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American Journal of Diseases of Children

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A CONTRIBUTION TO OUR KNOWLEDGE OF THE EXCRETION OF PHOSPHATES IN INFANCY *

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Studies of the nutritional disorders of infancy have occupied a conspicuous place in the literature of pediatrics during the last five to ten years. The newer and more accurate analytical methods, and the various metabolism beds contrived for use with young children, have made possible accurate work along these lines. Thus far, however, the data collected are still insufficient to establish a thorough understanding of the normal metabolism, and even less complete is the information at our disposal in regard to the pathological nutritional states. Any series of data, therefore, which adds even isolated facts to the sum of our knowledge, is of recognized value, and from this standpoint the data here collected are presented.

A number of early investigators observed that the excretion of phosphates in the urine of young infants was very low, but such observations were made on single specimens of urine only, and are therefore not of great value. The papers of greatest value and importance in this connection are those of Keller,[1] of Moll,[2] and of Koeppe.[3]

Keller observed that the excretion of phosphates in the urine of young, normal breast-fed infants is very low or *nil*, and that it gradually increases with the age of the child, as does the nitrogen excretion. He noted further that a normal infant on a diet of cow's milk excretes considerably more phosphorus in the urine than does the breast-fed infant, the increase in phosphorus excretion being greater than could be accounted for by the greater phosphorus content of the ingested food. Careful studies of the phosphorus content of the food, the urine and the feces show, Keller believes, that the phosphorus of cow's milk, though equally well, or even more completely, absorbed from the intestinal tract than

* From the laboratories of The Thomas Wilson Sanitarium, Baltimore, Md., and the Woman's Medical College of Pennsylvania.

* Submitted for publication Feb. 26, 1914.

1. Keller: Ztschr. f. physiol. Chem., 1900, xxix, 46; Ztschr. f. klin. Med., 1899, xxxvi, 49; Arch. f. Kinderh., 1900, xxix, 1.

2. Moll: Jahrb. f. Kinderh., three papers, 1909, lxix, 129, 304 and 450.

3. Koeppe: Jahrb. f. Kinderh., 1911, lxxiii, 9.

is the phosphorus of human milk, is less well retained and utilized by the body, a larger proportion appearing in the urine. The proportion of the total phosphorus in organic combination in human milk, 77 per cent., as contrasted with 27 per cent. of organic phosphorus in cow's milk, is cited as of probable importance in relation to this utilization by the body.

The study of the amount of organic phosphorus present in the urine leads this author to conclude that inorganic phosphorus only is related to the kind and amount of food, but that the organic phosphorus of the urine is not so related.

Moll's observations deal with breast-fed infants only, and lead him to striking conclusions as to the clinical significance of the phosphorus excretion. According to this author the normal breast-fed infant excretes in the urine practically no organic phosphorus, and the determination of the inorganic phosphorus by the uranium titration method is therefore sufficient for clinical purposes. Such normal infants excrete what he terms a "phosphorus-free" urine, that is, a urine containing no phosphorus at all, or mere traces, 0.010 gm. to 0.020 gm. of P_2O_5 (0.0043 to 0.0086 gm. P.) in twenty-four hours. A "phosphorus-rich" urine, that is, containing more than 0.020 gm. P_2O_5 (0.0086 gm. P.) in twenty-four hours, is excreted only under pathological conditions, and only in such cases can organic phosphorus be detected in the urine. This circumstance he believes to be related to excessive cell-destruction within the body.

From his observations Moll draws the following practical conclusions:

1. When a breast-fed child is contented, gains steadily in weight, shows no appearance of illness, and excretes no phosphorus or merely traces in the urine, it is well.

2. When an infant loses weight, and in the urine excretes no phosphorus, or mere traces, it is hungry.

3. When an infant loses weight, or fails to gain, and with apparently insufficient nourishment excretes considerable phosphorus in the urine, it is sick.

Careful observations of the phosphorus excretion, Moll believes, will serve as a useful check on the dietary procedures, the continued low excretion of phosphorus on increasing diet signifying that conditions are satisfactory, while an increased phosphorus excretion is a sign that digestive or nutritional disturbance is present.

Koeppe[4] reports a long series of observations on two normal infants. In one case the investigation included twelve experimental periods over

4. These were infants brought into the children's home showing some signs of rachitis, but on proper care and diet they gained normally in weight and gave every appearance of health.

a stretch of five months, the child being 6 months old at the end of the observation; in the other case there were six experimental periods, at intervals during three and a half months, the child being 7½ months old at the end of the observation. Both children were bottle-fed, and the diet was varied during the observation, including for different periods "butter-milk soup," cow's milk diluted one-half, cow's milk diluted to two-thirds strength, whole cow's milk, oatmeal water and cow's milk containing an addition of 1 gm. of sodium chlorid.

Koeppe draws the following conclusions: 1. *On equal quantities* of food the amount of P_2O_5 excreted in the urine varies with the *kind* of food. 2. On the *same kind of food,* the amount of P_2O_5 excreted is conditioned by the *amount of food.*

This author points out, however, that if the P_2O_5 of the urine is determined by the uranium titration alone, representing therefore only the phosphate excretion in the urine, it is important that this should be correlated with the phosphate of the food, determined also by the uranium method, and cannot properly be correlated with the total phosphorus of the food, as has usually been done. Following this method, however, he also concludes that "within certain limits the phosphate content of the urine is dependent on the phosphate content of the food."

Takacs[5] notes that in normal infants phosphorus is absent from the urine, or present only in traces, while in infants suffering from digestive disturbances the phosphorus excretion is increased in proportion to the severity of the disturbance. His observations cover seventy-five cases. No reference was made to the diet in the abstract of this paper available.

The relation of the excretion of calcium to phosphorus in both feces and urine is of interest, and is discussed by Wolff.[6] This author quotes the observations of Bahrdt[7] that the amount of calcium normally present in infant feces was two to three times as great as would be required to bind the fatty acids present, and that it must, therefore, be associated in other ways for excretion.

That such calcium is excreted in the form of phosphate is a legitimate suggestion. Wolff's experiments, as shown in his first table, indicate, however, that while the phosphorus of the feces is increased with the calcium of the feces on an abundant diet, no change in the phosphorus excretion of the urine occurs under these conditions. There does not appear to be a diversion of phosphorus from urine to feces in connection with a high calcium content of the feces.

5. Takacs: Phosphor im Sauglings Urin. Budapesti orvosi usseig. 1911, xliv.
6. Wolff: Jahrb. f. Kinderh., 1912, lxxvi, 180.
7. Bahrdt: Jahrb. f. Kinderh., 1910, lxxi, 249.

Wolff concludes that the phosphorus of the urine is derived from proteins, the source of the urinary nitrogen, and therefore parallels the nitrogen excretion. It is thus of different source and significance from the fecal phosphorus, which is derived from food phosphate from the bones, and from intestinal secretions.

Mörner[8] reports on the P_2O_5 excretion in a series of cases of cholera infantum. No statement of the amount or kind of food in these cases, nor of the severity of the clinical symptoms, is included in his table. The figures for the P_2O_5 excretion, however, are so variable as to suggest little relation to the clinical picture.

TABLE 1.—MÖRNER'S TABLE—CHOLERA INFANTUM[8]

Age of Infant, Months	Body Weight, Grams	P_2O_5 in 24 Hrs., Grams
2½	.....	0.02
3½	.....	0.34
4	4,700	0.03
4	3,350	0.29
3	2,500	0.16
7½	5,200	0.05
7½	5,200	0.12
2½	3,650	0.62
	NORMAL INFANT	
4	6,900	0.34
4½	4,800	0.26

The series of observations here reported from The Thomas Wilson Sanitarium for Children is of interest in that it adds considerably to the published data on this subject. It was our object in making this study to determine if possible whether Moll's observations in regard to the clinical significance of the phosphorus excretion in the urine of breast-fed infants would hold good for artificially fed children. Inasmuch as most of the children suffering from digestive and nutritional disorders are the "bottle babies," it seemed worth while to confirm and if possible broaden, the application of Moll's observation.

In no case was as extensive a series of observations on a single infant made as in Koeppe's study but, on the other hand, our figures include a number of differing clinical conditions.

Preliminary experiments with collections of feces as well as urine at once made clear the fact that with our children, suffering from more or less severe intestinal disturbances, the varying admixture of blood, mucus and pus with the fecal material would make the study of the stools from the point of view of the phosphorus excretion of comparatively little value. We therefore confined ourselves to the study of the

8. The reference is from Keller's paper in Ztschr. f. klin. Med., 1899, xxxvi (see Note 1). Mörner's table was compiled by Keller from Mörner's Nagra undersökeringar af urin och af blod fran fall af cholera infantum. Beilage zu Sven van Hofsten Cholera Infantum. Stockholm, 1887.

nitrogen and phosphorus excretion in the urine, in correlation with the nitrogen and phosphorus of the diet.

For phosphorus determinations the uranium titration method was used throughout for the urinalyses, the Neubauer method for the food mixtures. The Kjeldahl-Gunning method was used for the nitrogen determinations. With very few exceptions two check analyses were made in every instance.

The appended table, in which the cases are arranged in order of decreasing urinary phosphorus excretion, suggests the bearing of the diet on the phosphorus excretion. In the cases in which the phosphorus and nitrogen of the urine are not parallel an unusual dietetic reason is apparent.

Our experience with many of our cases has impressed on us the value of at least one twenty-four-hour metabolism bed observation on every child admitted to the hospital. Only in this way can an accurate knowledge of the kidney function be obtained. With the continual passage of diarrheal stools any estimation of the amount of urine is impossible. We are confident that in a number of instances a toxic condition was properly related only by the metabolism bed procedure to kidney insufficiency, rather than to the intestinal condition. Such a routine practice, in a large babies' hospital, demands a large staff of competent nursemaids, but the accurate diagnoses thus obtained warrant the care involved.

Nearly all the patients studied were suffering from some form of gastro-intestinal or nutritional disturbance, some of them of severe grade. An examination of the table will indicate that our figures do not justify any deduction as to the degree of derangement from the amount of phosphorus in the urine.

In order to show clearly the clinical condition with reference to the urinary phosphorus, the histories of the patients in the order in which they appear in the table are briefly summarized.

CASE 1.—E. L., (105). Admitted July 8, aged 6 months. Weight, 3.5 kilos. The patient had never thrived. He had been fed on various milk mixtures. There were rachitic bone changes. Vomiting was frequent. The stools were not numerous and were fecal in character. He had several attacks of bronchitis. On a whey-whole-milk mixture there was at first some improvement. His diet July 15 contained 1.58 gm. of nitrogen and 0.44 gm. of phosphorus and there was excreted in the urine July 15, 0.99 gm. nitrogen and 0.139 gm. phosphorus and on July 16, 1.45 gm. nitrogen and 0.22 gm. phosphorus. For six days after this period the child's condition remained unchanged. Then a sudden collapse occurred which ended fatally. Diagnosis: Malnutrition (decomposition).

CASE 2.—W. A. (4 and 231). Admitted August 5, aged 5 months. Weight 4.3 kilos. The patient was breast fed for six weeks, after which time he was weaned to cow's milk and later to condensed milk. He had always been sickly and had vomited frequently. The stools were green and contained mucus. He was first admitted June 11 and remained a month. In this time all acute symp-

TABLE 2.—DATA—

Name and Number	Date	Age in Months	Weight in Kilos	C.C. Liquid in Food of 24 Hours	Total C.C. Volume of Urine in 24 Hours	Nitrogen, Grams in Urine of 24 Hours
1—Lucas (105)	July 16	6	3.5	.....	260	1.45
2—Allenwalt (231)	August 10	5	4.3	780	475	1.23
3—Castor (241)	August 21	4	3.2	378	204	1.57‡
4—Pell (272)	August 20	6	5.6	791	390	2.51
5—Elm (212)	August 14	7	5.5	1,533	900	2.04
1—Lucas (105)	July 15	6	3.5	.....	160	0.99
6—Gaines (145)	July 30	7	5.0	960	710	1.39
4—Pell (272)	August 19	6	6.0	756	305	1.94
7—Rottenberg (277)	August 21	5	3.9	539	295	0.45
3—Castor (241)	August 20	4	3.2	626	378	1.21
8—Watkins (214)	August 13	8	3.5	784	415	1.50
5—Elm (212)	August 2	6.5	5.6	588	161	0.78
9—Yoekel	July 26	4	...	1,080	465	1.05
10—Harris	August 7	4	2.9	730	300	0.50
11—Rice	August 7	5.5	4.9	672	475	0.75
11—Rice	August 6	5.5	4.9	672	390	0.72
12—Horton	August 11	1.5	2.6	539	420	0.48
2—Allenwalt (231)	August 9	5	4.3	780	330†	0.69
5—Elm (212)	August 1	6.5	5.6	644	116	0.66
13—Saperstein (229)	August 8	8	6.6	569	80	0.71
14—Gessner (230)	August 7	2	4.8	426	140	0.47
15—Berstman (242)	August 13	12	7.6	890	600	1.18
16—Scott (76)	July 22	10.5	5.3	.....	515	1.12
15—Berstman (242)	August 12	12	7.6	868	82	1.09
8—Watkins (214)	August 14	8	3.5	896	455	0.89
4—Pell (272)	August 22	6	5.4	616	380	1.42
14—Gessner (230)	August 8	2	4.8	511	180	0.37
17—Kelchner (220)	August 5	3	3.4	504	235	0.43
17—Kelchner (220)	August 4	3	3.4	405.0	240	0.38
18—Smith (244)	August 12	8	4.3	505.0	352	0.92
18—Smith (244)	August 13	8	4.3	676	515	0.68
3—Castor (241)	August 14	4	3.1	672	378	0.68
3—Castor (241)	August 13	4	3.1	616	352	0.67
16—Scott (76)	July 23	10.5	5.3	.....	465	1.08
19—Edwards (203)	August 6	1.5	1.2	660	300	0.52

† Some lost. ‡ Twelve hours. * Estimated.

Phosphorus Grams in Urine of 24 Hours	Nitrogen, Grams in Food of 24 Hours	Phosphorus, Grams in Food of 24 Hours	Diet on Day of Observation	Clinical Diagnosis
0.22	1.58	0.44	Whey, whole-milk mixture.	Malnutrition (decomposition), fatal.
0.20	1.78	0.21	Whole-milk, rice-water mixture.	Indigestion, gastro-intestinal.
0.190	1.52	0.08	Coagulated egg-albumin.	Indigestion, gastro-intestinal, marasmus.
0.16	1.94	0.06	Raw egg albumin.	Indigestion, gastro-intestinal.
0.156	3.11	0.69	Whey, skimmed-milk mixture.	Indigestion, gastro-intestinal, nephritis, acute.
0.139	1.58	0.44	Whey, whole-milk mixture.	Malnutrition (decomposition), fatal.
0.138	2.47	0.30	Whole-milk, rice-water mixture.	Indigestion, gastro-intestinal, convalescent.
0.13	1.85	0.024	Raw egg albumin.	Indigestion, gastro-intestinal.
0.13	1.35	0.02	Raw egg albumin.	Indigestion, gastro-intestinal.
0.128	1.54	0.023	Raw egg albumin.	Indigestion, gastro-intestinal.
0.126	1.98	0.24	Whole-milk, rice-water mixture.	Indigestion, gastro-intestinal.
0.124	0.54	0.22	Whey.	Indigestion, gastro-intestinal, nephritis, acute.
0.117	2.10	0.25	Whole-milk, rice-water mixture.	Indigestion, gastro-intestinal.
0.117	2.519*	0.24*	*Eiweissmilch*, maltose mixture.	Malnutrition, indigestion, gastro-intestinal.
0.10	1.90	0.23	Skimmed-milk, barley-water mixture.	Congenital syphilis, dyspeptic, diarrhea.
0.091	1.90	0.23	Skimmed-milk, barley-water mixture.	Congenital syphilis, dyspeptic, diarrhea.
0.09	0.81	0.25	Whole-milk, whey mixture.	Malnutrition (indigestion, gastric).
0.09	1.78	0.21	Whole-milk, rice-water mixture.	Indigestion, gastro-intestinal.
0.09	0.054	0.22	Whey.	Indigestion, gastro-intestinal, nephritis, acute.
0.087	1.40	0.018	Raw egg albumin.	Iliocolitis, ulcerative.
0.08	0.56	0.16	Whole-milk, whey mixture.	Indigestion, gastro-intestinal.
0.078	0.30	0.013	Skimmed-milk, egg-albumin, water mixture.	Dyspeptic, diarrhea.
0.078	1.68*	0.23	Skimmed-milk, rice-water mixture.	Gastro-intestinal intoxication; fatal.
0.078	2.14	0.09	Skimmed-milk, egg-albumin, water mixture.	Dyspeptic, diarrhea.
0.078	1.98	0.244	Whole-milk, rice-water mixture.	Indigestion, gastro-intestinal.
0.072	2.02	0.04	Coagulated egg-albumin.	Indigestion, gastro-intestinal.
0.07	0.66	0.19	Whole-milk, whey mixture.	Indigestion, gastro-intestinal.
0.061	1.97	0.20	*Eiweissmilch.*	Indigestion, gastro-intestinal.
0.06	2.04	0.20	*Eiweissmilch.*	Indigestion, gastro-intestinal.
0.06	1.78	0.07	Egg-albumin, mother's-milk, rice-water mixture.	Spasmophilia, indigestion, gastro-intestinal.
0.06	1.87	0.096	Egg-albumin, mother's-milk, rice-water mixture.	Spasmophilia, indigestion, gastro-intestinal.
0.06	1.65	0.25	Skimmed-milk, rice-water mixture.	Indigestion, gastro-intestinal, malnutrition; fatal.
0.06	1.65	0.25	Skimmed-milk, rice-water mixture.	Indigestion, gastro-intestinal, malnutrition; fatal.
0.06	1.68	0.23	Skimmed-milk, rice-water mixture.	Gastro-intestinal intoxication; fatal.
0.03	....	....	Whole-milk, whey, mother's-milk mixture.	Inanition.

toms subsided. The stools became fecal and he was discharged well. Some time after his return home diarrhea returned and he was readmitted August 5.

August 9 and 10 his diet of whole milk and rice water contained 1.78 gm. nitrogen and 0.21 gm. of phosphorus each day, and his urine on August 10, 1.23 gm. nitrogen and 0.20 gm. of phosphorus. The child improved again rapidly and was shortly afterward discharged well. Diagnosis: Gastro-intestinal indigestion.

Note: The patient excreted about as much phosphorus in the urine as did the patient in Case 1, and yet the degree of nutritional disturbance was much less.

CASE 3.—M. C. (241). Admitted August 8, aged 4 months. Weight, 3.2 kilos. The patient had never thrived. He had been fed on a weak dilution of cow's milk at frequent intervals. A week before admission, vomiting and diarrhea had begun. The stools being fluid, green and containing mucus. On admission the child was thin and fretful with cool extremities and a subnormal temperature. August 13 and 14, on a diet of skimmed milk and rice water having a nitrogen content of 1.65 gm. and a phosphorus content of 0.25 gm. each day, there was excreted on the 13th, 0.67 gm. nitrogen, and on the 14th, 0.68 gm. nitrogen, and each day 0.06 gm. phosphorus.

A week later, August 20 and 21, on a diet of raw egg albumen and cooked egg albumen, respectively, the first having a nitrogen content of 1.54 gm. and a phosphorus content of 0.023 gm. and the second a nitrogen content of 1.57 gm. and 0.08 gm. phosphorus, there was passed 1.21 gm. of urinary nitrogen and 0.128 gm. urinary phosphorus August 20, and 1.57 gm. nitrogen and 0.19 gm. phosphorus in the urine August 21.

The child became progressively worse and died shortly after. Diagnosis: Gastro-intestinal indigestion; marasmus (decomposition).

CASE 4.—A. P. (272). Admitted August 17, aged 5 months. Weight, 5.6 kilos. The patient was fairly well nourished but a pale infant. He had been well for six weeks and breast fed. After this he had been given cow's milk and barley in too large amounts and had had frequent attacks of vomiting and fever followed by moderate diarrhea. For the purpose of observing the digestibility of raw versus cooked egg albumen, the child was given this diet for several days. For the remainder of the time he improved on a whole milk and barley-water mixture. August 19 and 20 on a diet of raw egg albumen the nitrogen of the food ingested amounted to 1.86 gm. and 1.94 gm. and the phosphorus to 0.024 gm. and 0.06 gm. The urinary nitrogen for the same periods was 1.94 gm. and 2.51 gm. and the urinary phosphorus 0.13 gm. and 0.16 gm., respectively.

August 22 on a diet of equal quantities of coagulated egg albumen having a nitrogen content of 2.02 gm. and a phosphorus content of 0.04 gm. there was excreted in the urine 1.42 gm. nitrogen and 0.072 gm. phosphorus.

The stools during both periods were two a day and fecal in character. No alteration in the condition of the patient was noticed during the first and second periods, although the urinary phosphorus varied greatly. Diagnosis: Indigestion, gastro-intestinal.

Note: This child excreted comparatively large amounts of phosphorus with small phosphorus intake in food and was in fair condition.

CASE 5.—T. E. (12 and 212). Admitted July 30, aged 6 months. Weight 5.5 kilos. The patient was breast fed for three weeks, then given condensed milk for a month. After this, diluted cow's milk. He was usually constipated and had several attacks of vomiting and diarrhea, for one of which he was admitted to the sanitarium in June. His acute symptoms subsided and he was discharged well after a month's stay. He was badly cared for at home and was readmitted July 30 in partial collapse. At this time the urine was scanty and contained albumen and numerous hyaline and granular casts.

August 1 on a diet of whey having a nitrogen content of 0.54 gm. and a phosphorus content of 0.22 gm. he eliminated by urine 0.66 gm. of nitrogen and 0.09 gm. of phosphorus, and August 2 on the same diet the urine contained 0.78

gm. nitrogen and 0.124 gm. phosphorus. The stools at this time were fluid and fecal. The patient's condition improved under treatment (salt solution by rectum, hot packs and stimulation) and on August 14, on a diet of skimmed milk and whey, having a nitrogen content of 3.11 gm. and a phosphorus content of 0.69 gm. he eliminated by urine 2.04 gm. nitrogen and 0.156 gm. phosphorus and the amount of urine increased from 161 c.c. August 2 to 900 c.c. August 12. The albumen and casts disappeared. A fortnight afterwards he was discharged in good condition. Diagnosis: Indigestion, gastro-intestinal. Nephritis acute.

Note: The increased phosphorus excretion in the later period of improvement is accounted for by the greater quantity of urine.

CASE 6.—A. G. (145). Admitted July 15, aged 7 months. Weight 5 kilos. The patient was sparely nourished but not acutely ill. He had been fed on diluted cow's milk at too frequent intervals. One week before he was said to have been fretful and feverish. This was followed by vomiting and a number of fluid green mucous stools. The symptoms had largely subsided on admission. When put on the metabolism bed the child was bright and without fever and the stools apparently normal.

July 30, while taking a diet of whole milk and rice-water, containing 2.47 gm. nitrogen and 0.30 gm. phosphorus, there was excreted in the urine 1.39 gm. nitrogen and 0.138 gm. phosphorus. Diagnosis: Indigestion, gastro-intestinal (convalescent).

CASE 7.—G. R. (277). Admitted August 19, aged 5 months. Weight 5 kilos. The child was plump at birth and breast fed for one month. After which he was given cow's milk and water. He has had repeated attacks of indigestion with vomiting and diarrhea and has lost much in weight. The stools are described as green and mucous. The patient was emaciated on admission, but seemed bright and hungry. He was given raw egg albumin for two days. This diet contained in twenty-four hours, 1.35 gm. of nitrogen and 0.02 gm. phosphorus. During this period the urinary nitrogen was 0.45 gm. and the phosphorus 0.13 gm. The child did well on a cow's milk mixture and gained in weight. Diagnosis: Indigestion, gastro-intestinal.

CASE 8.—J. W. (58 and 214). Admitted July 21, aged 8 months. Weight, 3.5 kilos. The patient had been breast fed only two weeks and then had been fed condensed milk and later cow's milk at frequent intervals. He had had much vomiting and occasional diarrhea. He was first admitted July 2 because of vomiting. This ceased promptly after the diet was regulated and the feeding intervals increased. He was discharged in twelve days apparently well.

A fortnight after his return home diarrhea and fever began again. The stools were green and mucous and flecked with blood. He was readmitted, having lost a pound in weight. The stools became fecal shortly after a water diet of two days followed by *Eiweissmilch*. A whole-milk-rice-water formula was substituted August 11. August 13 and 14 this mixture contained in twenty-four hours, 1.98 gm. nitrogen and 0.24 gm. phosphorus. August 13 there was eliminated in the urine, 1.50 gm. nitrogen and 0.126 gm. phosphorus, and on August 14, 0.89 gm. nitrogen and 0.078 gm. phosphorus. Diagnosis: Indigestion, gastro-intestinal.

Note: The unreliability of relying on a single sample of urine to determine the phosphorus content is shown in this case. August 10, 100 c.c. of urine contained 0.05 gm. phosphorus, and Aug. 11, 10 c.c. of urine contained 0.175 gm. phosphorus, with no apparent change in the patient's condition.

CASE 9.—J. Y. (116). Admitted July 23, aged 4 months. Weight 4 kilos. The child had never thrived. He had had frequent attacks of vomiting and diarrhea with watery movements but no fever. He had been fed on cow's milk at frequent and irregular intervals. His weight then only equaled his birth weight. July 26, on a diet of whole milk and rice-water having a nitrogen content of 2.10 gm. and a phosphorus content of 0.25 gm., the patient excreted in the urine, 1.05 gm. nitrogen and 0.117 gm. phosphorus. During this day the temperature was subnormal.

Diagnosis: Indigestion, gastro-intestinal.

CASE 10.—H. H. (237). Admitted August 6, aged 5 months. Weight, 2.9 kilos. The patient had never thrived. Many proprietary foods had been tried. Stools were eight to twelve in twenty-four hours, fluid, mucous with curds. His appearance was typically marantic, extremities cold, abdomen doughy, intestinal coils visible. August 7, on a diet of *Eiweissmilch* and maltose, and mother's milk containing 2.5 gm. nitrogen and 0.24 gm. phosporus in twenty-four hours, there was excreted in the urine, 0.50 gm. nitrogen and 0.117 gm. phosphorus.

Diagnosis: Malnutrition, severe grade. Indigestion, gastro-intestinal.

CASE 11.—J. R. (109). Admitted July 9, aged 5 months. Weight 4.9 kilos. The child had lesions of syphilis and a Wassermann reaction was markedly positive. Two weeks before admission the patient had had a gastro-intestinal disturbance accompanied by vomiting, diarrhea and fever. The stools were mucous and occasionally blood flecked. The temperature was elevated for a week after admission. Then the acute symptoms ceased, but there was much loss of weight on various milk mixtures, with lumpy stools containing mucus.

August 6 and 7, on a diet of skimmed milk and barley-water containing in twenty-four hours 1.90 gm. nitrogen and 0.23 gm. phosphorus, there was excreted in the urine 0.73 gm. nitrogen and 0.091 gm. phosphorus the first day, and 0.75 gm. nitrogen and 0.10 gm. phosphorus the second day.

Diagnosis: Acute dyspeptic diarrhea. Congenital syphilis.

CASE 12.—L. H. (239). Admitted August 7, aged 6 weeks. Weight, 1.6 kilos. The baby had never nursed; was given condensed milk for three weeks and then large quantities of cow's milk at frequent intervals. Vomited often; stools contained lumps; no diarrhea, steady loss of weight.

On admission the patient was emaciated, the extremities cold, eczema was present on face and scalp. The baby improved on a whole-milk-whey mixture. This diet on August 11 contained 0.81 gm. nitrogen and 0.25 gm. phosphorus, during which time the urine contained 0.48 gm. nitrogen and 0.59 gm. phosphorus. Diagnosis: Malnutrition (indigestion, gastric).

CASE 13.—D. S. (229). Admitted August 5, aged 8 months. Weight, 6.6 kilos. He had been quite well until the present illness. He was exclusively breast fed at somewhat irregular intervals. Three days before admission diarrhea had begun with mucous green stools, twelve to fifteen a day, some becoming blood-stained. There had been considerable fever but little vomiting. He was nursed until admitted to the sanitarium. The stools continued blood-stained and often purulent for a week and varied from six to sixteen in twenty-four hours. After this period they quickly became fecal in character.

August 8 on a diet of raw egg albumen and water containing 1.40 gm. nitrogen and 0.018 gm. phosphorus a day, the patient excreted in the urine, 0.71 gm. nitrogen and 0.087 gm. phosphorus. During this day of observation there were sixteen mucopurulent stools. The urine during the illness contained considerable albumen and a moderate number of hyaline and granular casts. Diagnosis: Ileocolitis, ulcerative.

Note: This case, one of moderately severe ulcerative ileocolitis, had a comparatively low urinary phosphorus content.

CASE 14.—M. G. (230). Admitted August 5, aged 9 weeks. Weight, 4.8 kilos. The patient had been fed on condensed milk for five weeks and then a cow's milk mixture. The illness began two weeks before admission with fever, vomiting and moderate diarrhea, the stools being four to six a day, green and mucous, never blood-stained.

On admission the patient was feeble, with poor circulation. She did well on a gradually increasing whey-whole-milk diet. August 7 the nitrogen of the food was 0.56 gm. and the phosphorus 0.16 gm. During this day the urinary nitrogen was 0.47 gm. and the urinary phosphorus 0.08 gm. August 8 on the same diet the nitrogen of the food taken was 0.66 gm. and the phosphorus 0.19 gm., and there was excreted in the urine, 0.37 gm. nitrogen and 0.07 gm. phosphorus.

Diagnosis: Indigestion, gastro-intestinal (convalescent).

CASE 15.—G. B. (242). Admitted August 8, aged 1 year. Weight, 7.6 kilos. Previous diet had been largely condensed milk. One week before admission the patient became dull and listless. Fever, nausea, vomiting and diarrhea followed, the stools being fluid, green and mucous, not blood-stained. The urine contained a trace of albumen and a few hyaline and granular casts.

August 12 and 13 on a diet of skimmed milk and egg albumin and water containing 2.14 gm. nitrogen and 0.09 gm. phosphorus, and 0.30 gm. nitrogen and 0.013 gm. phosphorus, respectively, there was excreted during the same periods in the urine, 1.09 gm. and 1.18 gm. nitrogen and 0.078 gm. phosphorus each day.

Diagnosis: Dyspeptic diarrhea.

CASE 16.—A. S. (76). Admitted July 5, aged 10 months. Weight, 5.3 kilos. The patient had had some indigestion all summer. He had been fed on cow's milk. The present illness began two weeks before with fever, vomiting and diarrhea. The child became worse and he was admitted in a dull, drowsy condition, with fever and mucous, semi-fluid stools, which shortly afterwards became blood-tinged. For a time there was improvement and the stools improved.

July 22 and 23, on a diet of diluted skimmed milk and rice-water, having for each day 1.68 gm. nitrogen and 0.23 gm. phosphorus, the urine contained on the first day, 1.12 gm. nitrogen and 0.068 gm. phosphorus and on the second day 1.06 gm. nitrogen and 0.06 gm. phosphorus. Shortly after this period when the patient was apparently doing well on a skimmed-milk-rice-water mixture, he rapidly sank and died. Diagnosis: Gastro-intestinal intoxication.

Note: In this case the phosphorus output differed markedly on two successive days and with no change in diet. The urinary phosphorus gave no suggestion of the hazardous condition of the patient.

CASE 17.—H. K. (220). Admitted August 1, aged 3 months. Weight, 3.4 kilos. The child had never been well. He had been fed on condensed milk at frequent intervals. A week before admission he had a gastro-intestinal attack with vomiting, fever and diarrhea. The stools were ten to twelve a day, fluid and mucous. The patient was pale and sparely nourished, tongue coated and slightly drowsy.

For twenty-four hours after admission sterile water alone was given; then diluted *Eiweissmilch*. On this diet August 4, which in twenty-four hours had a nitrogen content of 2.04 gm. and on August 5, 1.97 gm. and 0.20 gm. phosphorus each day, the patient excreted in the urine 0.38 gm. and 0.43 gm. nitrogen on August 4 and 5, respectively, and 0.06 gm. phosphorus each day.

Diagnosis: Indigestion, gastro-intestinal.

CASE 18.—C. S. (244). Admitted August 9, aged 8 months. Weight, 9 pounds, 14 ounces. Previous diet condensed milk for six months, then one-third cow's milk and two-thirds rice-water, about 6 ounces at frequent intervals. Several attacks of diarrhea occurred with eight to ten dark green stools a day, vomiting and fever, during the past six weeks. On admission the child was in a markedly spastic condition; extremities and spinal column rigid, temperature normal. A milk mixture was tried but vomited. August 12 and 13, on a diet of egg albumin, mother's milk and rice-water, the diet containing 1.78 gm. and 1.87 gm. nitrogen and 0.07 gm. and 0.096 gm. phosphorus, respectively, the patient excreted 0.92 gm. and 0.68 gm. nitrogen, respectively, and 0.06 gm. phosphorus in the urine each day. The stools at this time were six in twenty-four hours, small, semifluid, fecal with green mucus. The spastic condition continued. Temperature 99 F.

Diagnosis: Spasmophilia, indigestion, gastro-intestinal.

CASE 19.—J. E. Admitted July 29, aged 6 weeks. Weight, 1.2 kilos. A foundling said to have been fed on nothing but tea for three weeks before admission; temperature 95 F.; much emaciated. On a diet of skimmed milk and whey with some mother's milk the child improved. August 6, the weight increased to 1.6 kilos with three stools in twenty-four hours, light yellow, fecal. At this time the diet was whole milk ½ ounce, whey 1½ ounce, 16 per cent. cream, 1

dram; mother's milk ½ ounce at three-hour intervals. The 300 c.c. urine in twenty-four hours contained 0.52 gm. nitrogen and 0.03 gm. phosphorus.

Diagnosis: Inanition.

TABLE 3.—SUMMARY OF CLINICAL DIAGNOSES

	Case Nos.	Number
Dyspeptic diarrhea	11-15	2
Gastro-intestinal intoxication, acute	16	1
Ileocolitis ulcerative	13	1
Inanition	19	1
Indigestion, gastro-intestinal	2-4-6-7-8-9-10-14-17	9
Indigestion, gastro-intestinal, with nephritis	5	1
Malnutrition, severe grade, with indigestion, gastro-intestinal	1-3-12	3
Spasmophilia (spastic condition with indigestion, intestinal)	18	1
Total		19
Fatal cases	1-3-16	3

A consideration of the cases briefly outlined fails to suggest that in artificially fed infants the urinary phosphorus is a reliable indication of the severity of the derangement.

The phosphorus content in the urine varied markedly in the same clinical condition and in the same patient in succeeding days on a diet having about the same phosphorus content.

Kominie and Mayerhofer[9] have recently studied the phosphorus excretion in a long series of artificially fed infants. They found that the urine of these babies always contained more phosphorus than that of breast-fed children. They are of the opinion that the phosphaturia increases in intestinal disturbances and parenteral affections. They based their assertions on the observations of a small number of sick children (other cases cited being well artificially fed infants), and after examining only small portions (10 c.c.) of urine. In the cases cited, infants previously well and having a low phosphorus content in the urine became ill (in three instances from digestive disturbance, in one from pneumonia) and an increase in the urinary phosphorus was noted.

The infants in our series had been ill for some time before the urinary phosphorus was determined.

CONCLUSIONS

Our work confirms the earlier observations that the urinary phosphorus excreted in twenty-four hours by an artificially fed infant is greater than that recorded for the breast-fed child.

9. Kominie and Mayerhofer: Ztschr. f. Kinderh., 1913, viii, 24.

The data obtained, however, do not, in our opinion, justify the conclusion that any deduction as to the nature or severity of the nutritional derangement can be drawn merely from the amount of urinary phosphorus.

The estimation of the daily phosphorus excretion from small, single urine samples is unreliable, as the results thus are often at variance with those determined by examination of the twenty-four-hour urine.

A VOICE SIGN IN CHOREA*

PRELIMINARY REPORT

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I shall first briefly review the literature on chorea, then summarize that literature, mention the older methods, show the newer methods and the results obtained, with my conclusions.

The earliest recorded reference to voice changes in chorea is by John Eberle,[1] 1841, who said, "The voice is altered and articulation is indistinct and stuttering." From this date it is interesting to follow the literature somewhat chronologically.

Dunglison[2] in 1842 wrote, "The articulation is also affected at times so as to occasion stammering."

Romberg,[3] 1853 (Graves), cites three cases in which the respiratory function was profoundly affected.

Meigs and Pepper,[4] 1870, said, "The muscles of the internal and external respiratory apparatus are rarely affected."

Von Ziemssen,[5] who, according to Graves, seems to be the first to have paid particular attention to the disturbed respiratory function in chorea, says, previous "views are too ambiguous to permit of such interpretation," i. e., respiration is not involved. He says, "Irregularities are often observed in the act whether of inspiration or expiration which can only be interpreted as choreic."

Von Ziemssen describes a laryngeal chorea, and says, "It is a usual accompaniment of the severe form of the disease and characterized by insufficient force and duration of the tension of the vocal cords in phonation, owing to a want of coordination and persistence in the muscular act."

I would call especial attention to this statement, for it is to this that my own conclusions are added, and, as far as I know, have never yet been recorded.

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* Being contributions from the Psychopathic Hospital, Boston, No. 43 (1914. 9). The previous contribution, No. 42 (1914. 8), was by Dr. E. E. Southard, entitled "The Mind-Twist and Brain-Spot Hypotheses," and published in Psychological Bulletin, April 15, 1914. The present contribution (March, 1914) was read to the New England Pediatric Society, Feb. 27, 1914.

1. Eberle, John: A Treatise on the Practice of Medicine, 1841.
2. Dunglison, Robley: Practice of Medicine, 1842.
3. Romberg: Manual of Nervous Diseases, 1853, ii.
4. Meigs and Pepper: Practical Treatise on the Diseases of Children, 1870.
5. Von Ziemssen: Encyclopedia, 1877, xiv.

Althaus[6] in 1878 wrote: "The patient cannot sing because the respiration is jerky and explosive. That the diaphragm and abdominal muscles suffer is shown by unequal and irregular respirations."

Bristowe[7] in 1879: "The difficulty of speech depends not infrequently on the spasmodic affection of the larynx and respiratory muscles, which compels him to draw his breath suddenly through the laryngeal orifice with a strained sound."

Rosenthal[8] in 1879 said: "Speech is embarrassed, due to spasmodic action of muscles of respiration, of the larynx and pharynx."

Trousseau[9] in 1882: "Strange sounds are occasionally produced, the voice coming out in inspiration instead of expiration. Inspiratory muscles suddenly contract convulsively, cause the air to rush into the larynx so that from this kind of antagonism between the mind that wills the speech and the inspiratory muscles the voice undergoes a strange alteration."

Roberts,[10] 1884: "Respiratory movements are infrequent, jerky and irregular. Muscles of larynx are rarely implicated, those of the pharynx never."

James Ross[11] in 1885: "In laryngoscopic examination the vocal cords have been observed to act in an irregular and disorderly manner."

M. Allen Starr,[12] 1894: "Occasionally the laryngeal and respiratory muscles are affected and noises are made in the throat."

J. Lewis Smith,[13] 1896: "In rare instances chorea affects the respiratory muscles so as to produce a peculiar involuntary barking or squeaking voice by the forcible expulsion of air over the tense vocal cords."

Ch. Féré[14] in 1897: "The contortions of the features are associated with disturbance of speech."

C. E. Bewar,[15] 1898: "The respiratory muscles may act irregularly."

Wollenberg,[16] 1899: "Speech is in some degree in all cases, disturbed. . . . The patient can enunciate a few syllables, or perhaps only one, and then a deep and hasty inspiration occurs."

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6. Althaus: Diseases of the Nervous System, 1878.
7. Bristowe: Treatise on the Theory and Practice of Medicine, 1879.
8. Rosenthal: Clinical Treatise on Diseases of the Nervous System, 1879, ii.
9. Trousseau: Lectures, 1882, i.
10. Roberts: Theory and Practice of Medicine, 1884.
11. Ross, James: Handbook of Diseases of the Nervous System, 1885.
12. Starr, M. Allen: Chorea, in the American Text-Book of Diseases of Children, 1894.
13. Smith, J. Lewis: Diseases of Children, 1896.
14. Féré, Ch.: Spasmodic Neuroses, Twentieth Century Practice, edited by Stedman, 1897, x.
15. Bewar, C. E.: Diseases of Nervous System, 1898.
16. Wollenberg: Chorea, Paralysis Agitans Paramyoclonus Multiplex, Vienna, 1899.

Sachs,[17] 1900: "In some a peculiar condition of speech occurs which is in part due to difficulties in articulation and in part to choreic movements in respiratory muscles, necessitating rapid breathing."

Frederick Taylor,[18] 1900: "Speech is irregular and badly sustained and the patient cannot sing a long note. This is no doubt largely due to the imperfect action of the respiratory muscles."

Taylor and Wells[19]: "Speech is often defective (dysarthria) due to choreic action of the muscles used in articulation and also in respiration."

Butler,[20] 1904: "The speech is confused, indistinct and difficult."

Oppenheim,[21] 1905: "Irregular, spasmodic breathing occurs."

J. H. Musser[22]: "Irregular, jerky inspirations."

J. K. Monro[23]: "Speech often impaired, due possibly to involvement of the larynx. Speech is apt to be uttered quickly and be interrupted."

Osler,[24] 1906: "The inability to speak is in articulation rather than in phonation."

Edwards,[25] 1907: "Speech is quicker than normal and may be aggravated by irregular movements of the glottis and respiratory muscles."

Tyson,[26] 1907: "Speech is affected sooner or later in one-fourth of the cases, but the extent varies greatly from slight hesitation to incoherent, the difficulty being in the muscles of articulation rather than in phonation."

Guthrie,[27] 1907: "Speech is frequently indistinct and impossible from incoordination, coordination and spasm of muscles concerned in articulation and respiration."

Rotch,[28] 1906: "Speech may become slow and indistinct from affection of muscles of tongue and larynx."

"In severe cases the difficulty in speech may be enhanced by the mental condition, which may be represented by dulness and apathy and the child cannot or will not speak."

Holt,[29] 1906: "All degrees of speech disturbances are seen, from the slight difficulty in articulation due to inability properly to control the

17. Sachs: Treatise on the Nervous Diseases in Children, 1900.
18. Taylor, Frederick: Chorea in Practice of Medicine, edited by Gibson, 1900.
19. Taylor and Wells: Reference Handbook of Medical Science, Ed. 2, 1901.
20. Butler: Diagnosis of Internal Medicine, 1904.
21. Oppenheim: Lehrbuch der Nerven Krankheiten, 1905.
22. Musser, J. H.: A Practical Treatise on Medical Diagnosis, Ed. 5, 1905.
23. Munro, J. K.: Manual of Medicine, 1906.
24. Osler: Practice of Medicine, Ed. 6, 1906.
25. Edwards: Practice of Medicine, 1907.
26. Tyson: Practice of Medicine, Ed. 4, 1907.
27. Guthrie, L. G.: Functional Nervous Disorders in Children, 1907.
28. Rotch: Pediatrics, 1906, p. 934.
29. Holt: The Diseases of Infancy and Childhood, 1906, p. 724.

movements of tongue and lips, to a condition in which speech is almost impossible. In rare cases speech has been temporarily lost."

Starr,[30] 1913: "Occasionally laryngeal and respiratory muscles are affected; breathing is irregular and noises are made in the throat. Difficulty in talking and swallowing are serious. In a few instances speech becomes affected early and may be so indistinct as to be scarcely understood; in these cases grunting noises may be made in the throat."

Church and Peterson,[31] 1900: "The lips may be quickly pursed up or retracted, the tongue protruded or retracted, the teeth snapped together. In this way speech is impaired and becomes halting and explosive, due entirely to faults of articulation, as the larynx is practically never involved. The tongue is usually affected very early. Diaphragm is commonly invaded, causing irregularity of respiration and sometimes spasmodic noises, or peculiarly involuntary or clucking sounds." Graves made a painstaking study of respiratory irregularities which by a suitable self-registering apparatus he finds practically always present, even in mild cases, . . . and persist long after the more noticeable symptoms disappear.

Oppenheim,[32] 1904: "Tongue and other articulatory organs often take part in the twitchings. The tongue is thrown around in the mouth or protrudes through the teeth, causing a certain amount of disturbance of speech. The words are tossed out suddenly, broken off, or indistinct, separated by irregular respiratory movements. Gurgling and smacking noises are also produced by the action of the glossal musculature. Speech may be so disturbed the patient cannot utter a word for days or weeks. Respiratory muscles are generally affected, especially the diaphragm; irregular, spasmodic breathing occurs. Muscles of phonation are rarely involved."

SUMMARY OF PREVIOUS LITERATURE

To sum up, the literature contains many varied and vague terms in description of the voice in chorea. Among these such terms as "stuttering" "voice affected," "irregularities," "want of coordination and persistence in the muscular act," "strained sound," "embarrassed," "strange alteration," "squeaky voice," "disturbed," "defective," "confused," "indistinct and difficult," quicker than normal," "hesitation to incoherence," "*all degrees* of speech disturbance are seen!" "halting and explosive."

Any uniform statement of simple fact is everywhere lacking, making *in toto* a hodgepodge of inconsistencies.

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30. Starr: Nervous Diseases, Organic and Functional, 1913, p. 780.
31. Church and Peterson.
32. Oppenheim: Diseases of the Nervous System, 1904.

Had the method of approach been different their end-results and findings would have been conclusive and final.

To turn to their method:

SUMMARY OF PREVIOUS METHODS

No recording apparatus appears to have been used. Even Starr, in whose clinic Scripture was in charge of the speech laboratory, reports no graphic records.

Merely the eye and the ear were their recorders. However accurate these may be, the graphic record is surely better.

NEW METHODS OF VOCAL RECORD

The kymograph, equipped to register sound, records graphically what neither eye nor ear can detect. To do this there must be the special attachment of mouthpiece and nosepiece that register air movements in a closed tube on a membrane from which stretches a lever to smoked paper on a revolving drum. This method applied to the choreic voice yielded new facts.

WHAT THE KYMOGRAPH RECORDS

The voice kymograph—or the tambour with mouthpiece and connecting air space—records two changes in that contained air—pressure and vibration—pressure by a slow long rise of the pointer on the smoked drum, and vibration by a quick, short-excursion rise and fall. These rises and falls are made less frequent the lower in the scale the vibration is, and more frequent for the given space traversed the higher in the scale the vibration is.

In other words, when the apparatus is connected up with the respiratory passages the needle records respiratory air pressure and vocal cord vibration and variations in this pressure and vibration.

THE VOICE RECORD IN CHOREA

The patient sounded a prolonged A into the vocal kymograph. Normally this sound would record a uniform pressure and uniform vibration, shown in the even general elevation and the succession of equal small vibrations. Translating these then into vocal terms there would be an even intensity and even pitch.

The variation from the normal made by the choreic voice can easily be seen in the graphic records herewith.

They show the voice of chorea to be a sudden change in intensity and pitch. Example: down town.

After such a record has revealed just what the voice change is, its cause is easily traced.

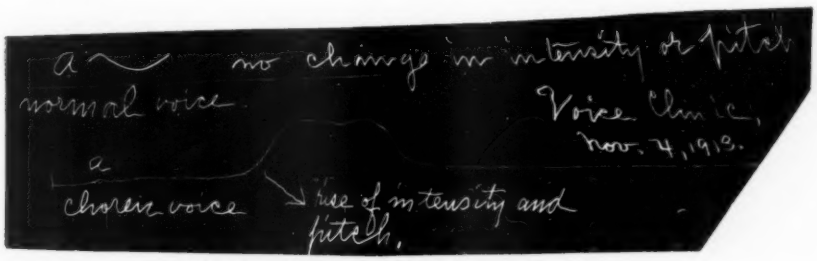
EXPLANATION OF THE VOCAL RECORD IN CHOREA

Increase of intensity comes from increased contraction of expiratory muscles, and rise in pitch results from increased contraction of the muscles of the vocal cords. And chorea makes these contractions. In other words, or stating the same in its order of sequence, choreic muscle contractions in the expiratory muscles makes increased air pressure, which results in increased intensity in the voice; and choreic muscle contractions in the muscles moving the vocal cords result in increased tension there, which increases the frequency of vibration and raises the pitch in the voice.

CONCLUSIONS

1. Choreic contractions cause changes of pitch and intensity in vocal utterance.

2 The most marked change is in the rendering of the vowel *a* as in *around*.



Tracing showing voice changes in chorea.

3. These changes occur so frequently[33] and so constantly accompany the choreic contraction as to give color to the claim that change of pitch and intensity are signs of chorea of equal dignity with the choreic knee jerk of Shaw,[34] and the respiratory signs of Graves.[35]

4. If I am right in finding no record of vocal changes of pitch and intensity in chorea in the literature to date, the present findings indicate a new sign in chorea which should be of some value!

SUMMARY

Examination of vocal utterance on the kymograph demonstrates a pretty constant voice change of rise in pitch and increase in intensity accompanying choreic movements—a vocal change—which deserves recognition as a new sign in chorea.

110 Bay State Road.

33. Swift, Walter B.: Reflex Frequency and Its Clinical Value, Jour. Nerv. and Ment. Dis., 1913, lx, No. 9.

34. Shaw, H. L. K.: The Knee Jerk in Chorea, Albany Med. Ann., May, 1897.

35. Graves, Wm. W.: A Study of the Respiratory Signs in Chorea Minor, Jour. Am. Med. Assn., 1909, lii, 364.

OBSERVATIONS ON THE PHYSIOLOGICAL ANATOMY OF THE INFANT'S STOMACH NOTED IN THE COURSE OF THE USE OF A BALLOON-DUODENAL CATHETER*

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Before entering on a discussion of the main subject of this paper, we wish to consider a physiological phenomenon associated with the passage into the gastric cavity of all catheters, and probably of all solid objects. In previous articles attention was drawn to the fact that a catheter introduced into the stomach or into the duodenum of an infant did not take the direction which, *a priori,* we should have anticipated, but followed a most peculiar course. We expected Roentgen-ray photographs to show that the catheter proceeds almost in a vertical direction from the cardia to the greater curvature, then to be deflected by the wall of the stomach, either to the right toward the pylorus or to the left, toward the fundus. However, such was not found to be the case; the course almost invariably was quite different: From the cardiac opening the catheter was seen to turn sharply to the left, without apparent cause, toward the fundus of the stomach; it then swung about on itself toward the pyloric opening. This course was pursued within the gastric cavity whether a very soft tube or a catheter was employed. From the very beginning of our studies carried out by means of the soft duodenal ball-tube, this peculiar phenomenon interested and puzzled us, so that we have undertaken a further investigation to determine the cause of this abrupt deflection toward the fundus.

Figure 1 shows that when a catheter is passed but a short distance into the gastric cavity, so that its tip lies free, not touching and uninfluenced by the wall of the stomach, even then it proceeds to the left. This test was made on numerous occasions and the result was always the same. It proves conclusively that contact with the wall of the stomach is not the cause of the deflection. Bearing this result in mind, we examined the anatomical relationship of the lower portion of the esophagus in infants. It was found that the abdominal portion of the esophagus measures about 2 cm. and that this part of the tube inclines sharply to the left. Indeed, this seems to be the condition even in the fetus. Fleischmann[1] states that in the seven-months fetus the esophagus lies

* Submitted for publication March 28, 1914.

1. Fleischmann, L.: Klinik der Paediatrik., Wien, 1875, p. 24.

in the mid-axis of the body and traverses the diaphragm at the ninth dorsal vertebra. "During this passage and even more thereafter, there is a marked change in its direction; it turns sharply to the left to reach the cardia." The cardiac end of the stomach also follows this direction for a short distance, thus furthering the inclination of the catheter to the left. The sharp bend of the catheter is therefore due to anatomical conditions—to the inclination of the lower end of the esophagus, especially its abdominal portion, and the contiguous cardiac portion of the stomach. The validity of this interpretation, and the entire independence of the phenomenon of all extraneous factors, such as the mode of introduction of the catheter or its deflection by the gastric wall, were emphasized by the following experiment:

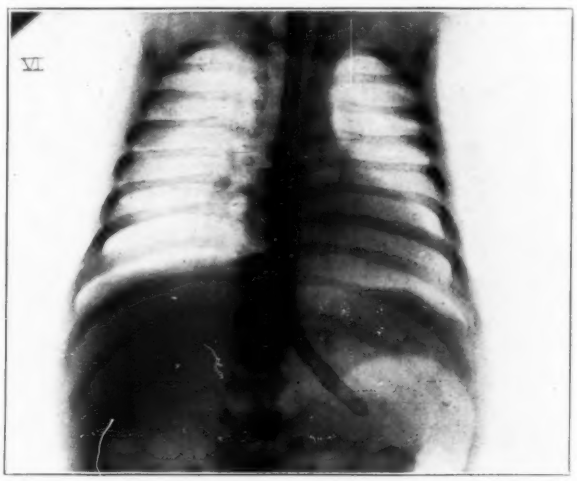

Fig. 1.—Catheter deviating to the left (tip free within gastric cavity).

A small metal ball was attached to a string, introduced past the pharynx into the esophagus, and its course followed by means of the fluoroscope. The ball, pushed downward solely by peristalsis, was found likewise to proceed to the left after traversing the diaphragm. When the support of the cardiac end of the stomach was lost, the ball dropped vertically to the greater curvature. On slowly retracting the ball by means of the string, it took a reverse course, as would be expected; first ascending vertically, and then sharply deviating to the right to reach the cardiac orifice.

The anatomical condition which leads to this phenomenon, although intensified in infants, seems to be present also in adults. Its physiologic basis would seem to be to direct all solid food to the fundus, the

site of the peptic and acid glands, and thus to ensure an intimate contact of food with the gastric ferments.

THE DUODENAL BALL-TUBE

In the use of the simple duodenal catheter a disadvantage consists in the fact that it is rarely retained in the duodenum for a long period. An infant suffering from vomiting, or even a normal infant, generally succeeds in ejecting it within the course of an hour. This has made it necessary when undertaking duodenal feeding, either to have the catheter constantly held in place by a nurse, or to reinsert it each time for feeding. Furthermore, where physiologic experiments have been carried out, it has rendered it impossible to collect material for long periods. As has been mentioned in a previous article,[2] attempts were made to overcome this difficulty. Recently a duodenal *"balloon-catheter"* has been devised and perfected by the author in order to constitute what

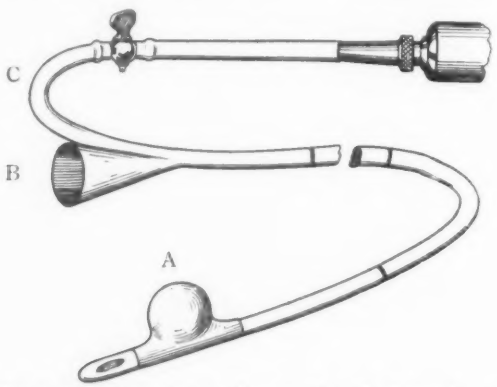

Fig. 2.—Balloon catheter; (a) balloon; (b) food canal; (c) air canal.

may be called a retention catheter. This balloon-catheter has an air tube of almost capillary diameter within its wall and opening near the tip into a rubber balloon, which is inflated with air (1.5 c.c.) when the end of the catheter has reached the duodenum (Fig. 2). In this way the return of the catheter through the pyloric sphincter is prevented. The diameter of the catheter proper is 15 mm., the same as that of the simple catheter; this diameter is increased to 19 mm. at the site of the rubber balloon.[3] The passage of this catheter naturally occasions some nausea, as do all tubes which traverse the pharynx, this disturbance varying greatly in different infants. However, after it has been in

2. Hess, A. F.: The Pancreatic Ferments in Infants, AM. JOUR. DIS. CHILD., October, 1912, iv, 213.

3. This catheter has been made by Eynard & Cie., Paris. Great difficulty was experienced in manufacturing a double catheter of the proper consistency and of this small diameter.

place for some hours the infant, just as the adult, becomes accustomed to it and ceases to fret. It has been retained in the duodenum for twenty-four hours, and with its aid infants have been fed every few hours.

We have not had sufficient experience with pronounced pylorospasm to judge to what extent the balloon-catheter is applicable in these cases. Although the catheter proper has a diameter not greater than the simple catheter, it will be noted that it is larger at the site of the balloon. Experience may demonstrate that it can be resorted to only in mild cases, and that where spasm is extreme it will be impossible to traverse the pylorus. Its practical scope in this field, both for feeding and for pyloric dilatation, remains to be ascertained in the clinic. In cases of

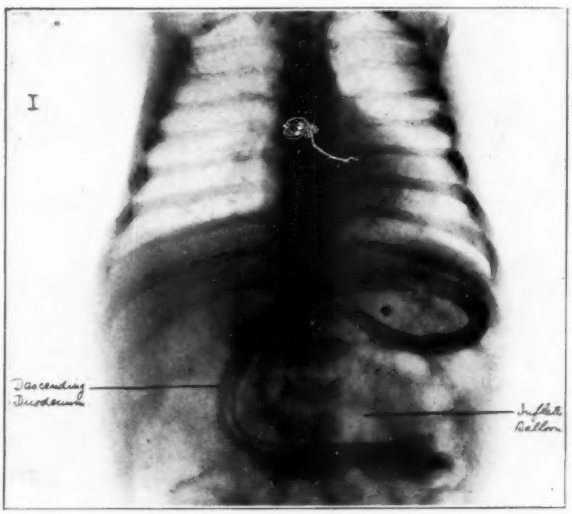

Fig. 3.—Balloon catheter (showing complete outline of duodenum).

mild spasm, or protracted vomiting from other cause, it has in a few cases been found serviceable for duodenal alimentation.[4] This new instrument is helpful in ascertaining whether the end of the catheter has in reality traversed the pylorus and reached the duodenum. This question has always presented difficulties, and unless bile was aspirated was often impossible to determine. By means of retracting the balloon-

4. In connection with a dilatable catheter for adults, Einhorn has also mentioned a similar instrument for use on infants, and claimed success in its employment. However, from the descriptions of the cases, it is doubtful whether this catheter actually passed the pylorus; in no case was this result confirmed by means of the radiograph. The description of the instrument for infants is meager; the important question of its diameter is not mentioned. It is propelled passively through the spastic pylorus.

catheter we can determine positively whether it is held by the cardia or by the pylorus, as will be seen by the measurements given below in connection with the measurement of the cardio-pyloric diameter.

In addition to describing this instrument, we wish to call attention to some observations concerning the physiologic anatomy of the stomach which have been noted in the course of the passage of the balloon-catheter. It is generally accepted that the long diameter of the infant's stomach lies horizontally, although there are some who still hold to the contrary, maintaining that the greater diameter is vertical. Radiographs of the stomach filled with bismuth, or filled with air, or of the empty stomach containing the catheter, clearly show the horizontal position of the stomach.[5] This statement of anatomic conditions, however, does not close the question from a physiologic point of view, for it has been demonstrated repeatedly that some of the milk that the infant drinks does not find its way to the fundus but flows directly and immedi-

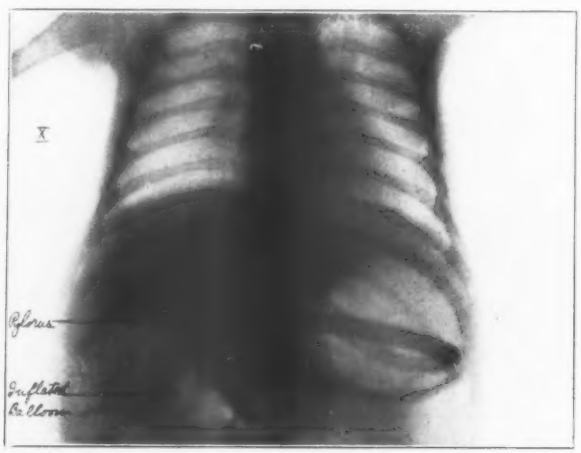

Fig. 4.—Balloon retracted almost to pylorus.

ately along the "*Magenstrasse*" of Waldeyer, the gastric canal of Lewis, through the pylorus and into the duodenum. Generally we have not found the duodenum empty even when we have taken a radiograph immediately after feeding. If we attempt to outline this gastric canal by drawing a line between the cardia (situated to the left of the tenth dorsal vertebra) and the pylorus, we shall find that its direction is downward and to the right, in a vertical rather than in a horizontal direction. This question can be studied better, however, by viewing

5. We have carried out all Roentgen-ray examinations with the infant lying on its back and not held upright. It would seem that this is the posture of choice as it represents the physiologic position of the infant.

some of the illustrations where the balloon-catheter was employed. Figure 3 shows this catheter and its dilated balloon well within the transverse duodenum; Figure 4 shows the balloon retracted almost to the pylorus; a third illustration (Fig. 5), taken a few minutes later shows the catheter fully retracted so as to do away entirely with the gastric loop. This photograph gives a clear picture of the path from the esophagus to the duodenum, and of the catheter within the *Magenstrasse*. And what do we find? The cardia still lying near the left border of the vertebral column and the catheter coursing downward, first to the left and then somewhat to the right to the duodenum, in an almost vertical direction. In other words, *the gastric canal* (*Magenstrasse*) *of the infant is much more nearly a vertical street, or path, than*

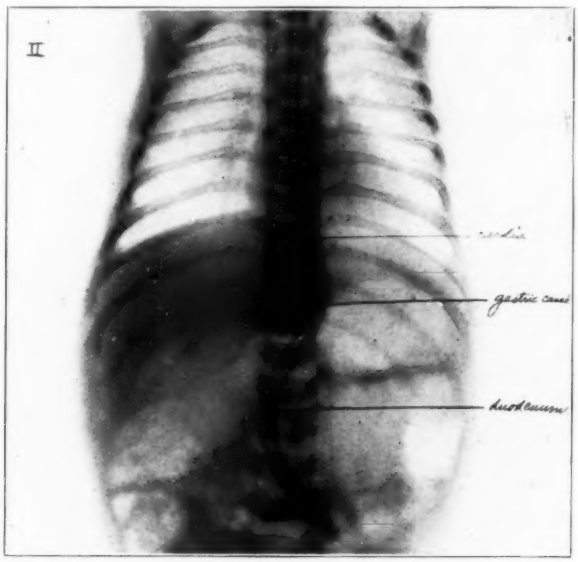

Fig. 5.—Balloon catheter retracted to do away with gastric loop.

a horizontal one.[6] Therefore, although it is true that the stomach of the infant lies horizontally, from a physiological point of view, the conception that it lies vertically has some justification. For from a functional standpoint some of the infant's food traverses the gastric canal in a

6. Figure 5 presents a rather exaggerated picture of the vertical nature of the gastric canal. For although the cardia in the infant is fixed, the pylorus is somewhat movable, and by the traction of the catheter in this instance has been pulled somewhat to the left. The bend of the catheter to the left along the cardiac end of the stomach has also been partly eliminated. However, these deviations are but slight, and it is evident that in the infant the cardia and the pylorus are very nearly in the same sagittal plane and that the gastric canal lies vertical rather than horizontal.

vertical rather than in a horizontal path, quite irrespective of the fact that it is skirting the main gastric cavity lying to the left. These various anatomic relationships are subject to some variation. For instance, the position of the pylorus is found to be altered somewhat when the stomach is full or when the colon is greatly dilated. The accompanying radiographs were taken with the stomach empty, as it was considered that this condition ensures more reliable observations; first, because the milk runs along the gastric canal at the very beginning of the feeding, when the stomach is empty, and second, because when bismuth or food is put into the gastric cavity it introduces a factor which is disturbing and which is not absolutely constant. This vertical direction of the gastric canal is peculiar to infancy. It does not obtain during later childhood or in adult life, and is an approximation to the vertical alimentary tube which is the normal condition in fetal life.

The length of the gastric canal can readily be measured by means of the balloon-catheter. If the catheter is retracted until the balloon is held at the pylorus, we can thus obtain the measurement of the distance of the pyloric sphincter from the alveolar borders. If the balloon is now deflated, retracted into the stomach, and inflated once more, we can obtain in the same way the distance of the cardia from the alveolar margin. The difference between these two measurements constitutes, naturally, the length of the *Magenstrasse*, or the gastric canal. In some infants about 2 to 3 months of age these measurements were as follows: the pyloric distance, 20 to 21 cm., the cardiac distance, 16 to 17 cm., so that *the cardio-pyloric diameter, or gastric canal, measured 4 to 4.5 cm.* This measurement is a remarkably constant one. It was found not to vary appreciably in children 2 to 3 months of age. It was not influenced by the inflation of the stomach with air or with water. When we compare this measurement, taken *in vivo*, with similar measurements obtained at autopsy, we find the former somewhat greater. For instance, Fleischmann gives the following figures for the cardio-pyloric diameter at various ages: At 1 week, 2.8 cm., at 1 month, 3.1 cm., at 2 months, 3.8 cm. He also states that if we multiply this diameter by 2.2 to 2.3 we obtain the long diameter of the stomach. If this holds true, then the long diameter of the stomach can be obtained during life by the method which we have described.

At various times we have emphasized the fact that cardiospasm is far more frequent among infants than is generally diagnosed. The cause of cardiospasm, just as the cause of pylorospasm, is unexplained. In view of this lack of knowledge it may be of interest to report that in several instances we have been able, by means of the balloon-catheter, to bring about cardiospasm artificially, although we could not invariably

accomplish this result. If the balloon was dilated within the stomach and then retracted so that firm pressure was brought to bear on the cardia for a few minutes, at times marked cardiospasm resulted. In some instances, after carrying out this procedure it was absolutely impossible to pass an ordinary catheter into the stomach. It is difficult to state whether this fact has clinical or pathologic significance. It suggests the possibility, however, that cardiospasm may be the result of increased pressure within the gastric cavity, that it may be incited by an overdistention of the stomach with food, or, more probably, with food and gas, and that the "*Magenblasse*," or air cushion, so constantly seen at the uppermost part of the infant's stomach may at times assume pathogenetic importance.

16 West Eighty-Sixth Street

THE METABOLISM IN OSTEOGENESIS IMPERFECTA WITH SPECIAL REFERENCE TO CALCIUM*

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NEW YORK

The incompleteness of our knowledge of the factors controlling calcium metabolism leads us to look for enlightenment to studies of disturbances of bone formation from this point of view. The disease under consideration is preeminently a disturbance of the development and calcification of all the bones of the body. We shall not review the clinical and pathological literature of the subject, as this has been well covered in recent articles.[1]

CASE REPORT

History.—A. W., admission number 127,906, history number 258. Admitted Jan. 12, 1912, to the service of Dr. H. Koplik, whom we wish to thank for the privilege of studying this case. Aged 10 weeks on admission.

Family History.—Russian Jewish parents. Two other children well. Mother had no miscarriages. Negative for tuberculosis and bone disease.

Previous History.—Normal birth, full term. Breast fed for three weeks, then placed on milk, one-third, water, two-thirds, 3 ounces every two hours. Bowels have moved once or twice daily. Stools at times greenish and foul smelling. Mother states that during the past summer she saw in the museum a colored woman with short arms and legs who "crept like a bear." Child has had its limbs curved since birth. Hernia also noted at birth. Said to have lost considerably in weight.

Physical Examination.—Male child, weight 6 pounds; small for his age; body length 17 inches; appears intelligent.

Head: Anterior and posterior fontanelles both the width of three fingers. Bones of the skull are soft and yielding to the touch except in the parietal region. Pupils: Equal, react to light, no apparent ocular palsies. Ears: Elfin in shape, long axis almost horizontal.

Lymph Nodes: Not palpable. No abnormality of spine; ribs show no rosary. Abdomen protruding. Edge of liver felt one finger below costal arch. Spleen not palpable. Bilateral complete inguinal hernia, readily reducible. Both testicles descended.

Extremities: Both arms and forearms considerably shorter than normal. Shafts of both humeri show angular deformity. The radius and ulna on both sides show the same deformity, angulation being most marked at junction of middle and lower third. Lower extremities much shorter than normal. Angular deformities with outward bowing of femur, tibia and fibula on both sides. Also anterior bowing of both legs. Deep hollow in outer aspect of both ankles. The ends of all the long bones of lower extremity are clubbed and their shafts are considerably thickened, especially at the points of deformity (pseudo-fracture).

Clinical Diagnosis: Osteogenesis imperfecta.

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* Submitted for publication April 1, 1914.

* From the Pediatric Service and the Department of Physiological Chemistry, Mount Sinai Hospital.

1. Schwarz and Bass: Am. Jour. Dis. Child., 1913, v, 131; Bamberg and Huldschinsky: Jahrb. f. Kinderh., 1913, lxxviii, Erganzgshft., p. 214.

Wassermann reaction negative, January 23 (Dr. D. J. Kaliski).

Management.—On admission the following food mixture was given:

Whole milk 12 ounces.
Barley gruel 18 ounces.
Divided into ten feedings, one dram of maltose being added to each.

On January 25 the mixture given during the first metabolism period was substituted for this. Calcium lactate was given, 5 grains every four hours from February 8 to February 17, except on February 13 and 14, when calcium chlorid was given. On February 9 there were four loose yellow stools. With this exception throughout the stay in the hospital there were one or two yellow stools daily, usually formed. February 15 and 16 the child vomited several times. February 16 the food was changed to:

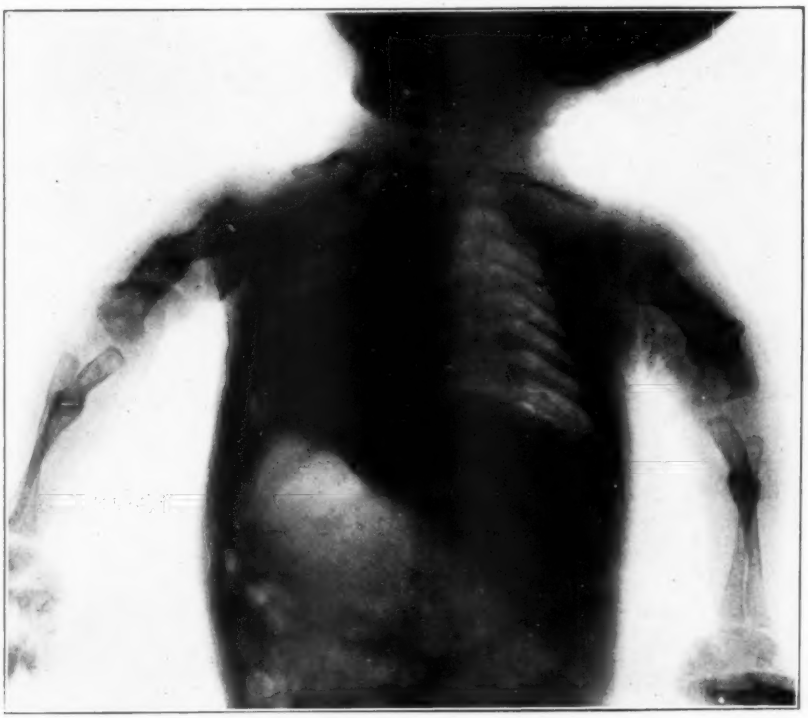

Fig. 1.—Author's case of osteogenesis imperfecta showing fractures, curvatures and marked deformities, and fractures of and callus formation on the ribs.

Skimmed milk 10 ounces.
Barley gruel 22 ounces.
Given in eight feedings with maltose, 1 dram in each.

February 23 the following mixture was given: Whole milk 12 ounces, barley gruel 20 ounces; in eight feedings, milk sugar 1 dram in each feeding. From February 25 to March 8, 4 ounces of breast milk were given three times daily in addition. March 5, calcium lactate was again administered, 5 grains being added to the feeding, q. i. d., and this was continued through the second metabolism period.

The temperature was quite normal throughout.

The child left the hospital April 23, 1912, weighing 7 pounds, 5 ounces.

Urine: The routine examination of the urine showed nothing noteworthy. The reaction during the metabolism periods was always slightly acid to litmus paper.

Roentgen-Ray Examination.—Roentgen-ray report by Dr. L. Jaches, to whom we are also under obligation for the accompanying plates, was as follows: The long bones show fractures, curvatures and marked deformities. Some show cystic conditions. There is no clear differentiation between cortex and medulla, except in tibiae and fibulae, where the cortex is very thin. Both humeri and radii and most of the ribs show fractures with callus formation.

Fig. 2.—Author's case of osteogenesis imperfecta. Lower extremities shorter than normal with angular deformities and outward and anterior bowing of long bones.

For the collection of specimens during each of the six-day metabolism periods, the child remained in the metabolism bed devised by Dr. H. Koplik,[2] and appeared comfortable. The stools were not marked off. Instead an enema of distilled water was given just before each experiment and again at the end, the result of the latter being added to the feces collected during the period.

Analytical Methods.—Total nitrogen, Kjeldahl; ammonia, Folin aeration method; creatin and creatinin, Folin; calcium and magnesium, McCrudden[3] method; feces and food being first ashed in a platinum dish.

2. Koplik and Crohn. Am. Jour. Dis. Child., 1913, v, 236.
3. McCrudden, F. H.: Jour. Biol. Chem., 1910, vii, 83.

Total sulphur and phosphorus: Urine oxidized by Benedict's[4] method; stool and food by Wolff and Osterberg's[5] modification, sodium chlorid being added as suggested by Bauman.[6] Sulphur weighed as $BaSO_4$. Phosphorus after precipitation with ammonium molybdate, weighed as $Mg_2P_2O_7$.

Fat in stools was determined by Kumgawa-Suto method. All analyses were made in duplicate.

Period 1.—From February 1, 10 a. m., to February 7, 10 a. m., age 12 weeks. Weight at beginning, 2,760 gm.; weight at end, 2,920 gm.

Feeding:

Top milk (16 ounces) 10 ounces.
Barley gruel 22 ounces.
Milk sugar 5 drams.
Nine feedings daily, one dram maltose added to each.

Days	1	2	3	4	5	6
Quantity of food taken, c.c.	736	944	832	944	784	880
Quantity of urine, c.c.	320	480	420	520	390	480

The child received approximately 164 calories per kilo body weight daily.

The specific gravity of the urine was 1.006 to 1.010. On the first day the total nitrogen was 0.412 gm., total ammonia nitrogen 0.041 gm., creatinin on the first day 9.12 mg., about 3.4 mg. per kilo body weight. Creatin present only in traces. Total weight of dried feces 25.2 gm.

TABLE 1.—Result of Metabolism Experiment, Period 1

	Fat	N	CaO	MgO	S	P
Food, total	114.7	7.424	2.737	0.3995	0.5535	1.373
Per diem	19.1	1.237	0.456	0.0666	0.0922	0.229
Urine, total	.....	3.693	0.072	0.0628	0.317	0.372
Per diem	.....	0.615	0.012	0.0105	0.053	0.062
Feces, total	9.91	0.868	2.344	0.281	0.1097	0.362
Per diem	1.65	0.145	0.391	0.047	0.0183	0.06
Retention						
Grams per diem.....	17.45	0.477	0.0536	0.0093	0.0211	0.1066
Percentage of intake...	91.3	38.5	11.7	13.9	22.9	46.5

Period 2.—Age 17 years. From March 9, 10 a. m., to March 15, 10 a. m. Weight at beginning, 2,984 gm.; at end, 3,112 gm. Fed on:

Top milk (16 ounces) 18 ounces.
Barley gruel 26 ounces.
Milk sugar 5 drams.

Eight feedings daily; maltose 1 dram added to each. Calcium lactate, 5 gr., added four times daily to the food. Analysis of this showed it equivalent to CaO, 0.214 gm. daily, which is included in the total calcium of the food in the table.

Days	1	2	3	4	5	6
Quantity of food taken, c.c.	960	960	960	1,088	1,000	960
Quantity of urine, c.c.	410	530	410	460	530	470

The child received approximately 178 calories per kilo body weight daily. Total weight of dried feces, 32 gm.

4. Benedict: Jour. Biol. Chem., 1909, vi, 366.
5. Wolff and Osterberg: Biochem. Ztschr., 1910, xxix, 429.
6. Bauman and Howard: Arch. Int. Med., 1912, ix, 665.

Except for the sulphur, the first period shows a considerably smaller retention of the constituents determined than the second. In the former alone need the adequacy of the diet to the needs of the child be considered. The nitrogen intake and retention during this period are ample. The phosphorus retention of 46.5 per cent. is materially higher than that of two normal children examined by Cronheim and Mueller[7] (6 per cent. to 26 per cent.), although the absolute weight retained is about the same as the average of their experiments. The absolute retention of phosphorus per diem in Schwarz and Bass'[1] case of osteogenesis imperfecta was 0.0274 gram, the percentage of retention was 42.5, both being below our figures.

The calcium retention in the first period is very low compared with that of normal children of about the same age (Table 3), and is paralleled only by that of Tobler and Noll's case. This is not due to any deficiency in the calcium intake of our patient, which is well above 0.23

TABLE 2.—RESULTS OF METABOLISM EXPERIMENT, PERIOD 2

	Fat	N	CaO	MgO	S	P
Food, total	171.9	12.192	5.7614	0.5787	1.3105	2.0626
Per diem	28.65	2.032	0.9602	0.0964	0.2187	0.3438
Urine, total	.....	6.3645	0.1448	0.0977	c....	0.3995
Per diem	.....	1.0607	0.0241	0.0163	0.0775	0.0666
Feces, total	12.49	1.0132	3.203	0.2839	1.413	0.3849
Per diem	2.08	0.1688	0.534	0.0473	0.2355	0.0641
Retention						
Grams per diem.....	26.57	0.8024	0.4023	0.0328	0.0946*	0.213
Percentage of intake...	92.7	39.4	42.	34.	43.3*	61.9

* Deficit.

gram CaO given by Orgler[8] as the daily requirement of infants aged from 2½ to 10½ months, while the retention in our case is less than half of what would be found to be the low limit in normal metabolism (0.12 gm.). The average retention he found was 0.17 gram. These quantities are the same for breast fed as for artificially fed children.

In Table 3 we have sought to include all the available figures on calcium intake and retention obtained in normal children between 2½ and 6 months, and have excluded all with a history of recent fever or digestive disturbance. In the cases cited the range is from 0.017 to 0.24 gram CaO retained per diem for the single periods, and the average retention for all periods is 0.132 gram. The children Lö. and Hu. reported by Cronheim and Mueller show the greatest variations. It should be noted that they were fed on a calorically insufficient diet

7. Cronheim and Mueller: Biochem. Ztschr., 1908, ix, 76.
8. Orgler: Ergebn. d. Inn. Med. u. Kinderh., 1912, viii, 166.

TABLE 3.—Calcium Intake and Retention Per Diem in Osteogenesis Imperfecta and in Normal Children

Author	Period	Age, Months	Weight, gm.	Feeding and Medication	Grams, CaO		Retention in Percentage of Intake
					Intake	Retention	
Osteogenesis Imperfecta:							
Schwarz and Bass (1)	.....	7	3,400	Mixed breast milk.....	0.239	+0.109	45.7
Bamberg and Huldschinsky[1]	I	2+	3,400	Mixed breast milk.....	0.296	—0.019	
Bamberg and Huldschinsky[1]	II	.....	.....	Mixed breast milk.....	0.265	+0.111	
Bamberg and Huldschinsky[1]	III	.....	.....	Mixed breast milk.....	0.308	+0.035	
Bamberg and Huldschinsky[1]	IV	.....	.....	Mixed breast milk, cod liver oil added	0.259	+0.014	
Bamberg and Huldschinsky[1]	V	.....	.....	Mixed breast milk, cod liver oil and phosphorus added	0.265	+0.118	
Bamberg and Huldschinsky[1]	VI	.....	.....	Mixed breast milk, cod liver oil and phosphorus added	0.236	+0.136	
Bamberg and Huldschinsky[1]	Average of I, II and III	.....	.....	Without medication	0.267	+0.0423	15.8
Bookman	I	3	2,800	Cow's milk mixture.....	0.456	+0.0536	11.7
Bookman	II	4	3,000	Cow's milk with calc. lactate added.	0.9602	+0.4023	42.
Normal Children:							
Cronheim and Mueller,[7] Child Lo.*	.....	3 +	4,000	Cow's milk mixture.....	0.91	+0.081-0.24 +0.156	17.1
Cronheim and Mueller,[7] Child Hu.*	.....	5 +	8,100	Cow's milk mixture.....	1.51	+0.017-0.226 +0.118	7.8
Tobler and Noll[9].....	.....	2½	4,000	Breast milk	0.239	+0.0533	22.3
Michel and Peret[10].....	.....	3	4,700	Breast milk	0.527	+0.2086	39.5
Orgler,[11] Child H. G.....	.....	2½	3,800	Cow's milk mixture.....	0.702	+0.123	17.5
Orgler,[11] Child Max G.....	.....	5½	6,700	Cow's milk mixture.....	1.23	+0.128	10.4

* Average for five periods.

9. Tobler and Noll: Monatschr. f. Kinderh., 1910, ix, 210.
10. Michel and Peret: Bull. Soc. d'Obstetrique, 1899, ii, 98.
11. Orgler: Monatschr. f. Kinderh., 1911, x, 373.

averaging for Lö. about 90 and for Hu. about 85 calories per kilo. The low figure of 0.0533 gram obtained by Tobler and Noll is from a single period, and has been included, although the authors state that they "can not affirm unqualifiedly that the child is to be considered quite healthy." We consider it probable, therefore, that the true normal average on sufficient feeding lies nearer the figure given by Orgler than that obtained from the normal children we have cited, and that the normal variations are also less marked than in the cases which form the basis of our table.

The magnesium retention in Period 1 (0.0093 MgO per diem) is also low. Cronheim and Mueller's children,[7] gave values from 0.015 to 0.042 gram MgO per diem. Schwarz and Bass' case of osteogenesis imperfecta also had a higher retention (0.0155 gm.).

In the second period the change of diet was slight. The weight in grams of the nutritive constitutents per 100 c.c. was computed as follows:

	Fat	Protein	Carbohydrate
Period 1	2.24	0.92	6.5
Period 2	2.8	1.3	5.31

The analyses at hand on normal children do not justify any conclusion as to what is to be considered a normal standard of sulphur retention. Tobler and Noll's child of 2½ months retained 0.0225 gram S per diem, while Blauberg's infant of 5 months retained only 0.0039 gram. Heiman, Bookman and Crohn[12] report on a child of 8 months with amaurotic family idiocy which on artificial feeding had the very high retention of 0.371 and 0.6985 gram in two different periods. Our first period with retention of 0.0211 gram per diem may be considered within normal limits. The percentage retention and absolute retention per diem both correspond closely to Schwarz and Bass' findings in their case (25.5 per cent. and 0.0212 gm.).

A loss of sulphur of 0.159 gram per diem during a single period is shown by the artificially fed child of 6 months reported by Blauberg,[13] which, however, had the low intake of 0.0584 gram. This finding makes unnecessary any special comment on the smaller loss of S in our second period. It is of interest that Blauberg's infant, like ours, showed simultaneously a large retention of CaO (0.924 gram per diem), so that it is clear that for a time at least the sulphur and calcium balance may bear no relation to each other.

The absolute retention of 0.4 gram CaO per diem in our second period marks a relatively high level, this being almost eight times the amount retained in the first period. The relative retention increases in almost the same proportion.

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12. Heiman, H., Bookman, S., and Crohn, B. B.: Am. Jour. Dis. Child., 1912, x, 234.

13. Blauberg: Ztschr. f. Biol., 1900, xl.

A loss in magnesium coincident with a gain in calcium has frequently been noted, recently, for instance, by Schloss[14] while giving phosphorus and cod liver oil with calcium acetate in rickets. In our patient there is no indication of this. The increase in magnesium retention in the second period, in which calcium lactate was given, is, however, less marked than in calcium.

Returning to our discussion of the calcium metabolism in osteogenesis imperfecta, we find in Schwarz and Bass' infant of seven months an absolute retention per diem of 0.109 gram CaO, which scarcely reaches the lowest limits of the normal. In Bamberg and Huldschinsky's[1] case we find variations from a loss of 0.019 to a gain of 0.136 gram, the latter figure being obtained under treatment with cod liver oil and phosphorus. The effect of this medication in this disease is still a matter of conjecture. It is noteworthy that the two periods when cod liver oil and phosphorus were given showed the highest values of their series, and it seems fair to assume that the higher retention in these two periods is attributable to the medication.[15] It is well known that cod liver oil and phosphorus have this effect in rickets. To arrive at a fair estimate of the calcium retention in their patient, we must then omit the last three periods of their observation from the calculation. Their first period the authors prefer to disregard for no clear reason. Averaging the untreated periods I, II and III, and we would have an average retention per diem of 0.0423 gram CaO, or for periods II and III alone of 0.073 gram. This approaches very closely the figure obtained in the first period in our own case.

These three cases of osteogenesis imperfecta then show a subnormal calcium retention, the highest figure being reached in the case of Schwarz and Bass, which was 4 to 5 months older than the others. Perhaps largely on that account the disease had already reached the stage of a more nearly normal calcium exchange. Furthermore, from the description of their case it appears to have been of a milder form.

The effect of the increased calcium ration in our second period furnishes confirmation of these views. The greatly increased calcium retention makes a striking parallel to the increased retention on the addition of calcium acetate to the diet which Orgler has demonstrated[11] in rickets and ascribes to the beginning of the healing process. In normal children he found that addition of calcium acetate to the diet had either no effect on the retention or was followed by a loss.

It appears then that just as is the case in rickets the calcium retention in osteogenesis imperfecta may be influenced favorably by cod liver oil and phosphorus (Bamberg and Huldschinsky's periods V and VI)

14. Schloss, E.: Jahrb. f. Kinderh., 1913, lxxviii, 694.
15. This child subsequently developed rickets.

and still more strongly by adding calcium lactate to the food.[16] This effect in the two diseases is so similar as to suggest inevitably that it is caused by some factor common to the pathology of both. The nature of this factor must remain for the present purely a matter of speculation.

To an earlier paper[17] on a case of osteopsathyrosis idiopathica in a man of twenty-seven years who showed a marked loss of calcium during a six-day metabolism experiment, we intentionally gave a clinical rather than a pathological title, as the clinical features appeared to us to point to some disturbance of the organs of internal secretion, and no autopsy could be performed. This patient showed a loss of 0.019 gram CaO per kilo body weight daily, and it is likely that osteogenesis imperfecta, were the metabolism to be studied in a rapidly progressive case, would show a similar loss.

Even in well-controlled metabolism experiments wide variations in the balance of various constituents may occur without discoverable cause. Deductions from them become progressively more valuable as they are based on a larger number of carefully controlled experiments, and must therefore remain subject to continual revision.

We believe the facts at hand in osteogenesis imperfecta justify the following conclusions:

1. In active cases the calcium retention is somewhat below or very decidedly below the normal.

2. It is probable that variations in the course of the disease cause changes in the calcium balance.

3. The deficient retention of calcium is apparently influenced favorably by cod liver oil and phosphorus, and still more strongly by calcium lactate.

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16. Schloss (Note 14) has recently shown that in rickets a combination of cod liver oil and phosphorus with calcium has a more decided effect than either alone.

17. Bookman, A.: Arch. Int. Med., 1911, viii, 675.

PROGRESS IN PEDIATRICS

A SUMMARY OF PRESENT KNOWLEDGE OF HUMAN MILK

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THE BREAST GLANDS

Glands which secrete milk are present, as a rule, only in the female mammal during and after pregnancy. A few drops of milk may be squeezed from the breasts before parturition, but, generally speaking, milk is present in them only after delivery.

According to Czerny and Keller[1] if the infant does not empty the breasts and they fill up again with secretion, there is a change in the composition of the milk as the result of absorption of the different components of the milk. It is, therefore, necessary to differentiate between the milk of women whose breasts are regulated and sufficiently emptied during nursing and that of women whose breasts are not sufficiently emptied. In the first there is no absorption of the milk components in the glands, while in the latter the chemical composition is more or less changed by absorption. They designate the latter as colostrum. Under this term they include all milk in which there has been any absorption; not only the milk in the breasts during pregnancy and the first few days postpartum, but also the milk when the secretion is in the process of drying up.

COLOSTRUM

All authors agree that the milk excreted during the first few days postpartum differs essentially from that after lactation is well established. It is of a deep lemon-yellow color. This color is present only during the first few days postpartum and is never seen at any later stage of lactation. Czerny (p. 408) believes, on the basis of his own work, that this color is due to a coloring matter contained in the fat drops. The colostrum is not as sweet as the later milk. It is coagulated into solid masses by heat. This depends, according to Tiemann,[2] on the presence of a globulin, which coagulates at 72 C. (161.6 F.). The amount of cholesterin and lecithin is greater than in milk.[3] The fat in colostrum contains less of the volatile fatty acids than does normal milk.[4]

1. Czerny and Keller: Des Kindes; Ernährung, Ernährungsstörungen, und Ernährungstherapie, Leipzig and Wein, 1906, 1, 407.
2. Tiemann: Ztschr. f. Physiol. Chem., 1898, xxv, 363.
3. Völtz: Oppenheimer's Handbuch der Biochemie, Jena, 1910, iii, i, 382.
4. Nilson: Maly's Jahresb., 1891, xxi, 142.

It is obvious that only those analyses of colostrum which have been made during the first days postpartum are of any value, as later it is mixed with milk. The specific gravity of colostrum ranges from 1.028 to 1.072, the average being about 1.040.[5] It has a strongly alkaline reaction.

J. Konig[9] gives the following percentages as the average of five analyses of early human colostrum: Water, 86.4; nitrogenous substances, 3.07; fat, 3.34; lactose, 5.27; salts, 0.40.

Pfeiffer,[6] found that the nitrogenous substances in human milk were as follows: First day, 8.6 per cent.; third to seventh day, 3.4 per cent.; during second week, 2.28 per cent.; in second month, 1.84 per cent.; in seventh month, 1.52 per cent. The amount of sugar increases

TABLE 1.—Composition of Colostrum as Determined by Various Investigators (Czerny and Keller)

Author	Day, Post Partum	Fat, Per Cent.	Lactose, Per Cent.	Protein, Per Cent.	Nitrogen, Per Cent.	Ash, Per Cent.	Solids, Per Cent.
Pfeiffer[6]	1	2.59	2.76	9.75	.....	0.408	.....
Pfeiffer	2	2.17	3.50	7.45	.....	0.340	.....
V. and J. Adriance[7]	2	3.77	5.39	3.31	.....	0.27	12.78
Camerer and Soldner[8]	26-51 *	4.08	4.09	....	0.928	0.48	16.04
	56-51 * †	3.92	5.48	....	0.508	0.41	14.12
	26-48 *	1.67	5.20	....	0.336	0.36	10.32
	48-68 * †	2.02	5.08	....	0.226	0.40	10.12

* Hours. † Same woman.

as the protein in human milk diminishes. The mineral composition of colostrum and breast milk is materially different. Table 2 shows the composition of one hundred grams of colostrum as compared to one hundred grams of milk.[10]

The findings of Burr, Bermerich and Berg[11] were somewhat different. They found that colostrum contained twice the amount of phosphorus, magnesium and calcium normally present in milk after lactation is well established.

Colostrum Corpuscles.—Microscopically the fat droplets in colostrum are more unequal in size than in ordinary milk. The colostrum also contains large numbers of granular bodies, known as "colostrum corpuscles." They are four or five times as large as the leukocytes, are

5. Burr, Berberich and Berg: Chem. Ztg., xxxvii, 69-71, 97-101.
6. Pfeiffer: Jahrb. f. Kinderh, 1883, xx, 365.
7. Adriance, V. and J.: Archives of Pediatrics, 1897, xiv, 22.
8. Camerer and Söldner: Ztschr. f. Biol., 1898, xxxvi, 277.
9. Konig, J.: Die Menschl. Nahrungs u. Genussmittel, Berlin, 1904, ii. 598.
10. Birk: Monatschr. f. Kinderh., 1910-1911, ix, 595.
11. Berg: Chem. Ztg. xxxvii, 146.

nucleated and are full of fat droplets. They are characteristic components of milk at the beginning of lactation, and are not found in later lactation. They have ameboid motion.[12] Czerny identified them as large leukocytes, whose cell membranes are completely filled with fat drops. These fat drops are smaller than those in the milk. He was able to demonstrate that the leukocytes of frogs possess the power of emulsifying fat drops and explains their small size in this way. He further emphasized the fact that it had previously been thought that these bodies were only present in the milk during the first days of lactation. Buchholz[13] noticed in 1877, however, that the colostrum bodies reappeared in the milk when nursing was stopped and the milk was drying up. Czerny repeated his work and found that the colostrum bodies always reappeared in the milk when lactation was interrupted for a few days, and that their numbers increased in direct proportion

TABLE 2.—COMPOSITION OF 100 GM. COLOSTRUM AS COMPARED WITH MILK (BIRK)

Colostrum (Birk)		Human Milk	
Ash	0.2814	0.0198	Langstein and Meyer
		0.2 -0.25	Abu-Neuberg
Calcium	0.0360	0.0328-0.0343	Bunge
		0.0378	Camerer and Söldner
Magnesium	0.0093	0.0064-0.0065	Bunge
		0.0053	Camerer and Söldner
Potassium	0.077	0.078 -0.0703	Camerer and Söldner
		0.088	Camerer and Söldner
Sodium	0.0544	0.0357	Camerer and Söldner
Phosphorus	0.1137	0.0473-0.0469	Bunge
		0.0591	Camerer and Söldner

to the length of time which had elapsed since the breasts were emptied. He concluded that colostrum corpuscles were always present when milk was formed in the breasts but was not withdrawn and that they disappeared when the breasts were sufficiently emptied of milk. Animal experiments show that the colostrum bodies pass from the breasts into the lymphatics. These colostrum corpuscles contain neutrophilic granules.[14] According to Deville,[15] they disappear from the milk between the eighth and tenth day in 51 per cent. of the cases. They may, however, in rare instances persist for many weeks.[16]

12. Czerny and Keller, page 409.
13. Czerny and Keller, page 410.
14. Cohn: Virchows Arch. f. path. Anat., 1900, clxii, 187.
15. Deville: Arch. internat. de méd. leg., 1913, iv, 60.
16. Steele: Arch. Pediat., 1910, xxvii, 32.

They are also phagocytic, in that they will consume bacteria. They have been shown to consume staphylococci, the colon bacillus, and the tubercle bacillus.[17]

When the breasts are not completely emptied, the protein and sugar are reabsorbed into the body earlier than the fat, which is taken up by the colostrum corpuscles only after five or six days. The sugar may appear early in the urine. The albumins in milk have a different hemolytic action from those in the blood of the same species, while those in colostrum react the same. On the basis of these facts, Bauer[18] argues that the proteins in colostrum are a direct transudate from the blood, while those in milk are manufactured by the mammary gland.

The protein of colstrum is characteristic since the greatest part of it will coagulate. Acid coagulation occurs very easily and the curd is tough.

The colostral fat is richer in oleic acid than is milk fat and as a result the iodin index is considerably higher.[19]

HUMAN MILK

Since the infant takes the milk directly into the mouth from the breasts, only such organisms as are in the breast gland itself can get into the milk.[20]

These investigations show that the milk of healthy women, whose breasts are free from pathologic conditions, contains micro-organisms in the majority of instances. In the majority of cases the organism is *Staphylococcus aureus*. Most investigators believe that the bacteria get in from the outside. Evidence in favor of this view is the fact that it is easier to demonstrate these organisms in the first part of the milk drawn than in the last part. Finally when the milk is withdrawn gently drop by drop, rather than strongly and rapidly, many tests are sterile. This fact makes it seem probable that the rough handling of the breast gland during nursing or by massage dislodges the bacteria and forces them into the milk.

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17. Thomas: Vortr. geh. a. d. Vereinig, Sachs-Thuring; Kinderarzte in Dresden, 1913, Ref.; Ztschr. f. Kinderh. (Ref.), 1913, vi, 28.

18. Bauer: Deutsch. med. Wchnschr., 1909, xxxv, 1657.

19. Engel: In Sommerfeld's Handbuch der Milchkunde, Wiesbaden, 1909, p. 810.

20. Escherich: Fortschr. d. Med., 1885, iii, 231; Cohn and Newmann: Virchow's Arch. f. path. Anat., 1891, cxxvi, 391; Palleske: Virchow's Arch., 1892, cxxx, 185; Honigmann: Ztschr. f. Hyg. u. Infectionskr., 1893, xiv, 207; Ringel: München. med. Wchnschr., 1893, xl, 513; Genoud: Sur la presence du staphylocoque dans la lait des accouchees bien portantes, Thèse de Lyon, 1894; Knochenstiern: Hyg. Rundschau, 1894, iv, 231; Halleur: Inaug. Diss., Leipzig, 1893; Brumm: Arch. f. Gynacol., 1886, xxvii, 461; Merit: Thèse de Paris, 1887; Johanessen: Jahrb. f. Kinderh., 1895, xxxix, 398; Roeper: Inaug. Diss., Marburg, 1896; Koestlin: Arch. f. Gynaecol., 1897, liii, 201.

Syphilitic lesions have been induced in rabbits by inoculating them with milk from syphilitic women, although the milk was sterile and no *Spirochaeta pallida* were found in the milk.[21]

Typhoid bacilli have been found by Lawrence[22] in the milk of a woman suffering with typhoid fever.

Under normal conditions no ill effects are caused by the bacteria in human milk. The children who take this milk thrive in spite of the presence of bacteria in the first portion of the milk. The bacteria in human milk have no pathologic significance for the healthy infant. It has been shown that this is not the fact in babies with disturbances of digestion. Moro[23] has recently ascribed to the staphylococci in human milk an etiologic rôle in the dyspeptic conditions of breast-fed infants.

1. *Appearance, Smell and Taste.*—Human milk has the same appearance as cow's milk, except that, when it is cooled, small white flakes are apt to stick to the side of the bottle. These flakes disappear when the milk is warmed. It has no odor and its taste is sweet. When the color becomes yellower than that of cow's milk it is due to an increased percentage of fat.

2. *Microscopic Appearance.*—It contains many minute fat droplets which are held in a state of permanent emulsion by the solution in which they are suspended. It may contain a few leukocytes and epithelial cells. The ultramicroscope shows numerous fine particles in lively molecular motion between the fat droplets. These particles are less numerous than in cow's milk. They are composed of casein.[24]

3. *Specific Gravity.*—The specific gravity averages between 1.030 and 1.032. It may fall as low as 1.020 and rise as high as 1.036.[25]

4. *Reaction.*—The reaction of human milk is amphoteric. It is acid to phenolphthalein and alkaline to litmus. The reason for the double reaction is the fact that the milk contains both mono- and diphosphates. The former are weakly acid, while the latter react as a base. If 10 c.c. of human milk are titrated with decinormal acid and litmus, it will require about 0.9 to 1.25 N/10 acid to neutralize them; it requires 0.12 to 0.55 N/10 NaOH with phenolphthalein. One hundred cubic centimeters of milk require 60 to 80 c.c. N/10 HCl to show the Gunzburg reaction.[26] The alkaline reaction of human milk is relatively stronger

21. Uhlenhuth and Mulzer: Deutsch. med. Wchnschr., 1913, xxxix, No. 19.
22. Lawrence: Boston Med. and Surg. Jour., 1909, clxi, 152.
23. Moro: Jahrb. f. Kinderh., lii, 542.
24. Alexander and Bullowa: Jour. Am. Med. Assn., 1910, lv, 1196; Mauntner: Arch. f. Kinderh., 1908-9, xlix, 29; Kreidl and Neumann: Pflügers Arch., 1908, cxxiii, 523.
25. Engel: In Sommerfeld's Handbuch der Milchkunde, Weisbaden, 1909, p. 774; Konig: Note 9.
26. Courant: Pflüger's Arch., 1891, l, 109; Escherich: Verhandl. d. Versamml. d. Ges. f. Kinderh. Heidelberg, 1889, 109.

than the acid reaction, but the absolute amount of acidity and alkalinity are less than in cow's milk. The electrical measurement of human milk as well as of all other milks is neutral.[27]

5. *Quantity.*—The amount of human milk secreted by healthy mothers depends on the demands of the infant. The twenty-four-hour amount of milk, therefore, depends in large part on the weight and strength of the infant. It is obvious that what might be a normal amount for one infant would be abnormal for another, and for this reason averages are of no greater value than the average weight of the infant. The figures representing the amount of milk taken by the infant are obtained by weighing either the mother or the baby before and after each nursing. Table 3 of Cramer's[28] figures shows the difference between the secretion of milk in primiparae and multiparae:

TABLE 3.—TWENTY-FOUR HOUR AMOUNT OF MILK IN GRAMS

Day postpartum	1	2	3	4	5	6	7	8	9	10
Nine babies of primiparae; average birth weight, 3,290 gm.....	4	78	183	199	236	299	303	274	362	384
Seven babies of multiparae; average birth weight, 3,348 gm.....	6	129	238	324	344	324	361	365	384	415

Table 4 from Czerny and Keller [29] gives the figures that Feer calculated as the amount of milk babies of the average weight (Camerer's figures) would take in the day. They do not differ much from those given by Camerer.

Czerny and Keller[29] (Vol. I, Chapter 18) should be consulted for a more detailed discussion of the amounts of breast milk secreted by the average woman. These amounts may be increased when a woman nurses two or more babies as does the wet-nurse. A wet-nurse[30] increased the amount of milk secreted in ten days from 720 grams when she nursed two infants to 1,750 grams when she nursed five infants.

6. *The Coagulation of Human Milk.*—The recent observations with the ultramicroscope[24] have helped to explain the coagulation of milk. The essential differences in the coagulation of human and cow's milk are as follows: The casein of human milk is precipitated with greater diffi-

27. Foa: Soc. Biol., 1905, lviii, 863; 1905, lix, 51.

28. Cramer: Klin. Beitr. z. Frage der kunstlichen Ernährung des Neugeborenen, Inaug. Diss., Breslau, 1896. Taken from Czerny and Keller Des Kindes, etc., Vol. 1, p. 356.

29. Czerny and Keller: i, 353.

30. Czerny and Keller: i, 458.

culty with acids or salts and it does not coagulate uniformly after the addition of rennet; and, lastly, the clot that forms does not appear in such large coarse masses as the casein from cow's milk, but is more loose and flocculent.

(a) *Precipitation with Acids.*—Bienenfeld[31] showed that there is a certain acidity at which the casein is precipitated most easily. When lactic acid is used, this point is between 22 and 24 c.c. N/10 acid to 100 c.c. of milk. If the milk is made acid up to this point and warmed to 40 C. (104 F.) the casein precipitates out of the solution. If the milk is diluted five times, the precipitation is accelerated. A watery, clear whey is left behind. Engel[32] showed that this was also true of strong

TABLE 4.—AVERAGE DAILY AMOUNT OF MILK DRAWN BY A BABY (FROM CZERNY AND KELLER)

Age in Weeks	Average Weight of Breast Fed Babies According to Camerer, Gm.	The Calculated Day's Amount of Milk, Gm.	Age in Weeks	Average Weight of Breast Fed Babies According to Camerer, Gm.	The Calculated Day's Amount of Milk, Gm.
1	3,410	291	14	5,745	870
2	3,550	549	15	5,950	878
3	3,690	590	16	6,150	893
4	3,980	652	17	6,350	902
5	4,115	687	18	6,405	911
6	4,260	736	19	6,570	928
7	4,495	785	20	6,740	947
8	4,685	804	21	6,885	956
9	4,915	815	22	7,000	958
10	5,055	800	23	7,150	970
11	5,285	808	24	7,285	980
12	5,455	828	25	7,405	990
13	5,615	852	26	7,500	1,000

acids (20 to 30 c.c. N/10 acid to 100 c.c. milk), but the best results were only seen at a certain degree of acidity. Slight variations above or below this point did not give good results. When acetic acid is used, more is necessary, i. e., 60 to 160 c.c. N/10 of the acid to 100 c.c. milk.

(b) *Rennin Coagulation.*—If a neutral solution of rennet is added to milk there is no macroscopic or microscopic change until the milk is acidified, but the ultramicroscope shows that the rennin ferment acts also in neutral solutions.[33] Although human milk does not coagulate uniformly with rennin, it has been shown that it is capable of coagu-

31. Bienenfeld: Biochem. Ztschr., 1907, vii, 262.
32. Engel: Locus. cit., Note 19, p. 775.
33. Kreidl and Neumann: (See Note 24).

lation.[34] After human milk has been frozen several days and then rennin plus acid are added, there is a definite coagulation. Human milk does not coagulate with rennin alone. Two factors may explain the diminished coagulability of human milk, viz., the relative alkalinity of the milk and its low calcium content.[35] Engel[36] saw a better precipitation when he diluted the milk with water that contained calcium, than when he used distilled water. The coagulation is also facilitated, if the milk is kept cold for several hours.[37]

The precipitate is characteristic and is always in more or less fine curds, which are never as large as the curd from acidified cow's milk. The curds in undiluted milk are especially fine and can be seen only with the microscope. It is interesting that they do not sink to the bottom in milk from which the cream has not been removed, but rise to the top. In skimmed milk they may fall to the bottom.

(c) *The Difference between Acid and Rennin Coagulation.*—There is no macroscopic difference. The ultramicroscope shows that neutral solutions of rennin cause the casein, which was previously invisible, to become visible.[33] Acid must subsequently be added to cause a definite precipitation. The curds from acid plus rennin coagulation are not so easily dissolved as those from acid coagulation alone. Chemically there results from rennin coagulation a casein body, which is rich in calcium—paracasein. The whey which results from rennin and acid coagulation, contains less nitrogen than that from acid precipitation.[19]

7. *Chemical Composition.*—The principal components of milk are fat, lactose, proteins, salts and water. It also contains small amounts of extractives and citric acid as well as certain unknown substances.

NITROGENOUS BODIES

1. *Total Nitrogen.*—The total nitrogen in milk is usually determined by the Kjeldahl method and this figure is multiplied by the factor 6.25, or 6.37, to give the albumin content. This method is, however, not free from error, because there are other bodies that contain nitrogen and yet are not classed among the albumins. These, according to various authors,[38] may make up between 17 and 20 per cent. of the total nitrogen. Taking this fact into consideration and deducting the non-albuminous nitrogen from the total nitrogen, there is, according to Camerer and Söldner, 1.04 per cent. of albumin in human milk.

34. Schlossmann and St. Engel: Oppenheimer's Handbuch, etc., iii, 430.
35. Fuld and Wohlgemuth: Biochem. Ztschr., 1907, v, 119.
36. Engel: Biochem. Ztschr., 1908, xiii, 89.
37. L. F. Meyers: Verhandl. d. ges. f. Kinderh., Stuttgart, 1906, p. 122.
38. Camerer and Söldner: Ztschr. f. Biol., N. F., 1898, xviii, 277; Rietschl: Jahrb. f. Kinderh., lxiv, 125.

The average figures as to the total amount of nitrogen in 100 c.c. of milk at different stages of lactation are[39] as shown in Table 5:

TABLE 5.—TOTAL NITROGEN IN 100 C.C. MILK AT DIFFERENT STAGES IN LACTATION (SCHLOSSMANN)

Days Post Partum	Total Nitrogen	Nitrogen Factor × 6.25
9 to 10	0.29	1.81
11 to 20	0.29	1.81
21 to 30	0.31	1.94
31 to 40	0.24	1.50
41 to 50	0.28	1.75
51 to 60	0.25	1.56
61 to 70	0.23	1.44
71 to 100	0.20	1.25
101 to 140	0.20	1.25
141 to 200	0.207	1.29
Over 200	0.21	1.31

The amount of albumin in the milk varies during the same day and even during a single nursing. These variations are, however, not of any great significance. Table 6 shows the variations in the milk of

TABLE 6.—VARIATION IN THE MILK OF EIGHT WET-NURSES DURING A SINGLE DAY (ENGEL)

Age of Nurse, Years	Day of Lactation	Amount, c.c.	Morning 5	Morning 9	Morning 12	Afternoon 3	Afternoon 6	Afternoon 10	Avg.
16	45	2,000	1.386	1.458	1.305	1.324	1.306	1.279	1.344
19	58	1,500	1.163	1.118	0.956	1.073	1.163	1.127	1.100
29	60	2,200	1.149	1.154	1.395	1.261	1.136	1.161	1.208
25	70	2,700	1.314	1.243	1.127	1.216	1.046	1.064	1.170
23	72	3,000	1.207	1.234	1.154	1.315	1.154	1.163	1.204
21	100	3,300	1.135	1.117	1.127	1.154	1.243	1.028	1.119
19	130	1,800	0.492	1.019	1.127	1.064	0.903	1.082	0.948
25	140	2,200	1.082	1.064	1.100	0.939	1.082	1.064	1.036
								Avg.	1.141

eight wet-nurses during a single day, samples having been taken from each of the nursings. The individual variations are so slight, however, that if the average for the day is taken and compared with the average for the stage of lactation, the same diminution in the amount of albuminous material during the progress of lactation is seen as in the table.[19] (The factor of nitrogen times 6.25 was used.)

39. Schlossmann: Arch. f. Kinderh., 1900, xxx, 324; 1902, xxxiii, 187.

2. *Residual Nitrogen.*—The residual nitrogen is that fraction of the nitrogen which is found in the filtrate after the precipitation of the albumins and which does not give the reactions for protein.[40] Part of this residual nitrogen is supposed to be in the form of urea (50 per cent. or more) and another part in an amino-acid or a peptid-like body.[41] There is less of it in cow's milk than in human milk. The significance of these bodies is unknown.

The milk and blood serum of a 21-year-old primipara with chronic nephritis (urinary albumin = 0.3 per cent.) were simultaneously examined on two occasions. The residual nitrogen of the serum was 5.33 per cent. and 7.43 per cent. of the total nitrogen; that of the milk was 27.19 per cent and 32.88 per cent., both being much above the normal. Urea was considered to be the probable cause of this increased amount.[42]

3. *The Albuminous Bodies.*—Human milk contains two groups of albuminous bodies: (1) *casein,* which is insoluble in water, and (2) *lactalbumin* and *globulin,* which are soluble in water. The separation of these bodies in human milk is more difficult than in cow's milk, because of the difficulty in precipitating the casein. There is, on this account, much opportunity for future investigations to add to our knowledge of the proteins of human milk. The figures which are most generally adopted are those of Schlossmann,[41] who found that about 41 per cent. of the total nitrogen is in the form of casein. From 15 to 20 per cent. of the toal nitrogen may, however, be residual nitrogen (see above). If this amount is deducted only 44 to 39 per cent. are left to be divided between the lactalbumin and globulin. Ciccarelli[43] found that the relation of casein to lactalbumin in human milk was 26.9-37.9 to 62.1-73.1. These figures show that there is considerable variation in the quantities of these bodies even in human milk. The following figures represent what may be considered averages. The total protein is divided as follows:

Casein, 41 per cent.; lactalbumin and globulin, 44 to 39 per cent.; residual nitrogen, 15 to 20 per cent.

Opalisin was described in 1888 by Wroblewski[44] as a new albumin which is present in very small amounts in cow's milk and in large amount in mare's milk. It is also present in human milk. Very little is known about this body.

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40. Munk: Virchöw's Arch. f. path. Anat., 1893, 134, 501. (First studied this body.)

41. Rietschel: Jahrb. f. Kinderh., lxiv, 125.

42. St. Engel and Murschhauser: Ztschr. f. physiol. Chem., 1911, lxxiii, 101.

43. Ciccarelli: La Pediatria, 1908, vi, 12.

44. Wroblewski: Ztschr. f. Physiol. Chem., 1898-99, xxvi, 308.

COMPARISON OF PROTEINS OF HUMAN AND COW'S MILK

Casein.—The facts that it is difficult to precipitate casein from human milk and that it takes large amounts of milk to obtain a sufficient quantity of casein for analysis have retarded our knowledge of the subject. For this reason more is known about cow casein than human casein.

Casein is insoluble in water, but is soluble in water to which alkalies have been added. If acid is added to this alkaline solution, the casein will again be precipitated. If enough alkali is subsequently added it will again go into solution. The analysis of casein is shown in Table 7.

TABLE 7.—ANALYSIS OF CASEIN (FROM ENGEL)

Author	C	H	S	P	N
Wroblewski[44]	52.24	7.32	1.12	0.68	14.97
Bergell and Langstein[45]..	53.01	7.14	0.71	0.25	14.60
	52.63	6.94	0.85	0.27	14.34

The sulphur content of cow and human casein is as follows:

Cow Casein		Human Casein	
Liebig[19]	Hempel[19]	Liebig	Hempel
0.723	0.723	0.094-1.079	1.072

According to these figures there is more sulphur in human than in cow's milk. They correspond closer to Wroblewski's figures than to those of Bergell and Langstein. It is still a disputed question whether the casein from different kinds of milk is identical or whether there are several different caseins. Recently Langstein and Edelstein found that the phosphorus content of human milk was 0.22 to 0.28 per cent. and that of cow's milk 0.85 to 0.87 per cent. and concluded that this was evidence that the two caseins were different compounds.

Bordet[46] showed that repeated injections of cow's milk into other animals caused a body to appear in the blood which precipitated the albuminous bodies of cow's milk and made them coagulate. Wassermann[47] and others went a step further and showed that the blood serum of animals sensitized to cow's milk would precipitate the albuminous bodies in cow's milk, but would not precipitate those in human milk or the milk of other animals, and that the blood serum of animals sensitized to human milk precipitates the albuminous bodies in human milk and does not precipitate them in the milk of other animals. In other words, the blood serum of an animal may be sensitized to the albumins

45. Bergell and Langstein: Jahrb. f. Kinderh., 1908, lxviii, 568.
46. Bordet: Ann. de l'Inst. Pasteur, 1899, xiii, 240.
47. Wassermann: Verhandl. des 18 Congr. f. Inn. Med., 1900, p. 501.

of a certain species of animal and react specifically to that species. These experiments can leave no doubt that the proteins of different animals are different.

Further investigations showed that casein, lactalbumin and globulin could be differentiated from one another by complement fixation and anaphylaxis experiments.[48] Milks of animals of one species can, therefore, be differentiated from the milk of animals of another species and the casein, globulin and lactalbumin of the same milk can be differentiated one from the other.

Fat.—The fat in human milk is in a very fine emulsion. When the number of drops are counted in a counting chamber there are always more in human milk than in cow's milk.[1] The fat globules in human milk measure between 0.001 and 0.02 mm., while those in cow's milk measure 0.0016 to 0.01 mm.[49] Since the measurements given above show that the fat drops in human milk may be of greater diameter than those in cow's milk, it seems inconsistent that there should be a larger number in the former than in the latter. The explanation must be that the majority of fat drops in human milk are small and measure about 0.001 mm., while the majority of those in cow's milk must be closer to the upper limit and measure nearly 0.01 mm.

Percentage and Quantity of Fat.—The figures as to the percentage of fat and the total amount of fat in human milk vary considerably according to the various investigators and the methods they pursue in obtaining their material. Engel's[19] monograph on human milk gives the most complete summary of the knowledge of this subject and is quoted freely in the following paragraphs. The percentage of fat is smallest at the beginning of nursing and largest at the end of nursing, the steepness of the curve depending on the total amount of milk taken at a nursing. When a small amount is taken, there is a sharp rise in the percentage of fat, and when there is a large amount of milk taken, there is a more gradual rise. Although the percentage may increase regularly throughout the nursing, this is by no means the rule. The three curves taken from Engel give examples of how the percentages of fat may increase (see Chart).

The percentage of fat in the first milk drawn varies between 1 and 3 per cent. and that in the last milk taken between 6 and 10 per cent. These figures may occasionally be even higher. There are cases on record in which there was more fat in the first part of the milk than in the last part and the curve is the reverse of the one just described.[50]

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48. Bauer and St. Engel: Biochem. Ztschr., 1911, xxxi, 46; Kleinschmidt: Monatschr. f. Kinderh., 1911-1912, x, 402.

49. Leaves: Ztschr. f. physiol. Chem., 1894, xix, 369; Ruppel: Ztschr. f. Biol., 1894, xxi, 1.

50. Engel: Arch. f. Kinderh., 1906, xliii, 181.

In pathological conditions the extremes of the percentage of fat are 0.1 per cent.[51] and 13.7 per cent.[52]

The average fat content of the milk of ten wet-nurses (German) examined by Engel was 4.5 per cent, and of 119 women (Russian) examined by Skvortzov,[53] 3 per cent. The amount of fat in the milk of the same women may vary from 25 to 100 per cent. in the same day at different nursings. When the intervals of emptying the breasts are long there is more milk and less fat. When all the milk of a woman is collected each day the average daily percentage is constant. This is true even if the total amount of milk is considerably increased.

Quality of Fat.—When fat is separated from human milk by dissolving it in ether, it forms a yellowish-white mass similar, at room temperature, to butter.

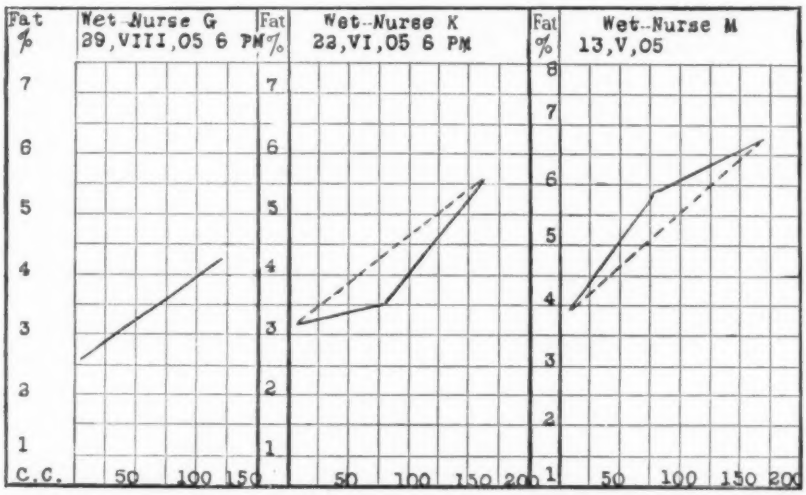

Chart from Engel.—The heavy black line indicates the increase in the per cent. of fat when the milk is examined at frequent intervals during a single nursing.

The melting point of human milk is between 30 and 34 C.

The solidifying point is between 19 and 22.5 C.

The specific gravity at 15 C. is 0.97.[54]

The fat of human milk is relatively poor in volatile fatty acids when compared with cow's milk.

Volatile fatty acid, human milk, 2.5 per cent. of total fat.

Volatile fatty acid in cow's milk, 27.0 per cent. of total fat.

51. Moll: Arch. f. Kinderh., 1908, xlviii, 161.

52. Engel: Arch. f. Kinderh., 1906, xliii, 194.

53. Skvortzov: Russki Vratch ii, p. 1392; Ref. Chem. Abstracts, 1913, vii, No. 18.

54. Ruppel: Ztschr. f. Biol., 1894, xxxi, 1; Laves: Ztschr. f. physiol. chem., 1894, xix, 369; Sauvaitre: Ref., Malys. Jahresb. d. Tierchemie, 1903, xxxiii, 324.

Among the volatile fatty acids have been demonstrated butyric, capronic, caprinic and caprylic acids. One-half of the non-volatile fatty acids are oleic acid, while among the solid fatty acids myristic and palmitic acids are found to be more abundant than stearic acid.[56] The large amount of oleic acid explains the relatively lower melting point and higher iodin value of human milk than of cow's milk.

The iodin value in human milk varies within fairly wide limits, but is usually found at about 45. There are women in whom it sinks to 32 and others in which it is as high as 50.[19] Certain observations go to show that the iodin value is in part dependent on the food. Goose fat, linseed oil[57] and iodized fats[58] have been demonstrated to pass from the food into the milk.

Lactose.—Lactose, or milk sugar, is found only in the milk of animals. It is essentially the same in the milk of the woman, the cow, ass, rabbit, dog and horse.[59] There is evidence[60] which suggests strongly that lactose is formed from the dextrose in the blood. The quantity of lactose varies the least of all the elements of human milk. The amount of lactose in human milk is almost twice that in cow's milk, being on the average about 7 per cent. The lowest percentage which has been found is 4.22[61] and the highest 10.9 per cent.[62] A few instances have been recorded in which the addition of sugar to the diet of the mother has increased the amount of sugar in the milk. This is, however, by no means the rule.[63]

Lecithin.—It has been estimated that 100 c.c. of human milk contains 0.058 gm. of lecithin.[64] The question has been raised, however, whether the body that was quantitated as lecithin was not a result of the breaking down of some of the phosphorus-containing bodies by the chemical manipulations during the investigation.

Nuclein.—There is considerable debate as to whether human milk contains nuclein or not. Three cases which were examined[65] showed an average per cent. during one year as follows: 0.1302, 0.1339 and 0.1305. The amount was inversely proportional to the quantity of the milk.

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56. Hammersten: English translation Text-book Physiological Chemistry, N.Y., 1909, p. 530.
57. Thiemich: Monatschr. f. Geburtsh. u. Gynäk., 1899, ix, 515.
58. Bendix: Deutsch. med. Wchnschr., 1898, xxiv, 223.
59. Deniges: Contribution a l'ètude des lactoses, Paris, 1892; Bonmartini: Rev. gén. du lait, 1906, ii, No. 1.
60. Porcher: Biochem. Ztschr., 1909-10, xxiii, 370; Paton and Cathcart: Jour. of Physiol., 1911, xlii, 179.
61. Pfeiffer: Verh. II, Versaml. d. Gesselsch. f. Kinderh., Wien, 1894, p. 131.
62. Schlossmann: Arch. f. Kinderh., 1900, xxx, 324.
63. Lust: Monatschr. f. Kinderh., 1913, xi, 236.
64. Burow: Ztschr. f. Physiol. Chem., 1900, xxx, 506.
65. Valenti: Chem. Zentralbl., 1909, i, 93.

Salts.—Total Ash: The average amount of ash in human milk is about 0.21 per cent.[66] The amount of ash diminishes during the course of lactation just as does that of the protein. This is shown in the following from Camerer and Söldner:

Days Postpartum	Per Cent. of Ash
8- 11 days	0.28
29- 40 days	0.22
60-140 days	0.19
170 days and later	0.18

Table 8 shows the percentage of the various salts in human milk to 100 parts of ash.

TABLE 8.—Percentage of Salts in Human Milk to 100 Parts of Ash (from Engel and Schloss)

	Bunge[67]	Blackhans and Kronheim[68]		de Lange[69]	Schloss[70]
	I	I	II		
K20	32.14	33.74	27.33	19.9	28.77
Na20	11.75	11.91	15.88	29.6	10.26
CaO	15.67	17.36	15.52	12.9	20.44
MgO	3.99	3.17	2.13	2.9	4.66
Fe203	0.27	0.63	1.75	0.25	
P205	21.42	14.79	11.75	17.9	22.0
CL	20.35	15.47	23.93	21.3	16.61

The composition of the ash of human milk is, according to Söldner[71] as shown in Table 9.

TABLE 9.—Composition of Ash of Human Milk (from Engel)

	100 Gm. Milk Contains, Mg.			100 Gm. Ash Contains, Mg.		
	First Milk	End Milk	Average	First Milk	End Milk	Average
K20	100.8	63.4	88.4	32.5	31.9	32.4
Na20	44.8	17.6	35.7	14.5	8.9	13.1
CaO	37.6	38.1	37.8	12.1	19.2	13.9
MgO	5.4	5.2	5.3	1.7	2.6	1.9
Fe203	0.22	0.12	0.2	0.07	0.06	0.07
P205	32.10	28.8	31.0	10.40	14.50	11.40
SO3	9.6	7.2	9.0	3.1	3.6	3.3
Cl	71.7	34.2	59.1	23.1	17.3	21.7

66. Camerer and Söldner: See Note 8; Pfeiffer: Verh. d. gesellsch. f. Kinderh., Wien, 1894, p. 126.
67. Bunge: Ztschr. f. Biol., 1874, x, 316.
68. Bericht d. landw. Inst. d. Univ. Konigsberg, v, 61.
69. De Lange, Cornelia: Ztschr. f. Biol., 1900, xl, 527.
70. Schloss: Ueber Sauglingsernährung, Berlin, 1912, p. 58.
71. Söldner: From Sommerfeld's Handbuch, etc., p. 800.

These figures show that the ash varies in amount, as well as other milk components, according to whether the sample of milk is taken at the beginning or at the end of nursing. It is obviously just as necessary to obtain milk under the same conditions and with the same precautions when the salts are to be investigated as when the other food components are to be studied.

Calcium.—A large number of analyses show wide individual variations between 0.03 and 0.08 per cent., with an average of 0.042 to 0.044 per cent. The daily variations may amount to as much as 0.02 per cent. The calcium content decreases as the period of lactation progresses. The amount of calcium cannot be increased by feeding the mother with calcium salts.[72]

Iron.—Friedjung[73] found from 3.52 to 7.21 mg. iron in a liter of human milk. This gives an average of 5.09 mg. This figure is somewhat higher than those given by Camerer and Söldner[74] and Bahrdt and Edelstein,[75] who found between 1.215 and 2.93 mg. per liter. The iron content of the milk is dependent on the general condition of the woman. It is higher in healthy individuals and lower in those under par. A regular decrease in the amount of iron during lactation has not been demonstrated. Neither have investigations of the iron content of the milk in pathologic conditions of either the mother or the baby given any figures of clinical significance.

Chlorids.—Freund[76] found that 1,000 c.c. of the milk of the same woman contained, on four successive days: 0.488, 0.498, 0.433 and 0.456 NaCl. Bunge obtained similar results.

Phosphorus.—There is a great difference in the form in which phosphorus is present in human and in cow's milk. Three-quarters of that in human milk is in organic combination, while only one-quarter of the phosphorus in cow's milk is in organic combination. The phosphorus which is in organic combination is considered by many to be in the form of lecithin and nucleon, which are present in larger amounts in human than cow's milk[77] (see lecithin and nucleon); 41.5 per cent. of the total phosphorus in human milk is in the form of nucleon phosphorus and only 6 per cent. in cow's milk.[77] Because of the larger

72. Bahrdt and Edelstein: Jahrb. f. Kinderh., 1910, lxxii, 16; Schabad: Jahrb. f. Kinderh., 1911, lxxiv, 511.

73. Friedjung: Arch. f. Kinderh., 1901, xxxii, 58; Jolles and Friedjung: Arch. f. exper. Path. u. Pharm., 1901, xlvi, 247; (entire literature to date).

74. Camerer and Söldner: Ztschr. f. biol., 1900, xxxix, 190; 1903, xliv, 71; 1905, xlvi, 371.

75. Bahrdt and Edelstein: Ztschr. f. Kinderh., 1910, l. 182.

76. Freund: Chlor. und Stickstoff in Sauglings organisms, Jahrb. f. Kinderh., 1898, N. F., xlviii, 137.

77. Siegfried: Ztschr. f. Phys. Chem., 1897, xxii, 575; Whittmaack: Ztschr. f. physiol. chem., 1897, xxii, 567; Burow: Ztschr. Physiol. chem., 1900, xxx, 495.

amount of casein and calcium phosphate which it contains, cow's milk is much richer in phosphorus than human milk. The relation of P_2O_5 to N is 1:54 in human milk, and 1:27 in cow's milk.[78] Keller[79] found that one liter of milk contained of P_2O_5:

Grams P_2O_5;

0.40 0.44 0.377 0.452 0.353	The mixed milk of different wet-nurses.
0.386 0.382	The same woman.

Sikes[80] gives 0.297 P_2O_5 to the liter as an average of figures in the first three weeks of life. The amount varies between 0.14 and 0.522. Schlossmann[78] gives as an average 0.461 P_2O_5 per liter. The phosphorus content of the milk depends in good part on the casein content of the milk.

Citric Acid.—The average amount of citric acid in human milk is 0.05 per cent.[81]

Unknown or Unidentified Substances.—Meigs and Marsh[82] report the presence of substances of unknown nature which contain little or no nitrogen and are soluble in alcohol and ether. Human milk immediately after the colostrum stage contains 1 per cent. of these unknown substances, while milk from the middle period of lactation contains about 0.5 per cent.; cow's milk from the middle period of lactation contains about 0.3 per cent. of these substances.

Viscosity.—There is in most cases a regular decrease in the viscosity of milk during the first twenty-four hours postpartum. There is no difference between the viscosity in normal or abnormal cases then or later. The *electrical conductivity* is almost always increased in abnormal cases. This increase is least when there is albuminuria and greatest when the supply of milk is scanty. There is a regular decrease in the electrical conductivity during the first week postpartum.[83] The degree of viscosity depends on the amount of solids, especially of casein in the milk.[84]

VARIATIONS IN THE COMPOSITION OF HUMAN MILK

Table 10 shows the lowest and highest figures given by various authors. These figures show that the variations in the percentage of fat are the greatest, but that there are considerable differences in the

78. Schlossmann: Arch. f. Kinderh., 1905, xl, 1.
79. Keller: Arch. f. Kinderh., 1900, xxix, 1.
80. Sikes: Jour. physiol., 1906, xxxiv, 464.
81. Scheibe: Quoted by Engel. See Note 19.
82. Meigs and Marsh: Jour. of Biol. Chem., xvi, No. 1.
83. Polenaar and Phillipo: Ztschr. f. Pathol., ix, 138.
84. Oertel: Dissertation, Leipzig, 1908, Ref. Arch. f. Kinderh., 1909, li, 282.

percentages of the other components of human milk. There are no figures in literature in which the percentages of all components are high or all low. Usually, when one component is increased, another is diminished.

The average composition of human milk is usually given as follows: Fat, 4 per cent.; lactose, 7 per cent.; protein, 1.50 per cent.; (casein 42 per cent, filterable nitrogen [including lactalbumin, globulin and unknown bodies] 58 per cent.); salts, 0.21 per cent.

The previous tables show that human milk may vary widely in its composition from these figures and still be normal.

INFLUENCE OF FOOD ON QUANTITY AND COMPOSITION OF MILK

The effect of food on the chemical composition of milk has been investigated and, with the exception of the work done on fats, does not warrant any conclusions. The fat in the milk may diminish when

TABLE 10.—VARIATIONS IN COMPOSITION OF HUMAN MILK (FROM CZERNY AND KELLER)

	Fat, Per Cent.	Sugar, Per Cent.	Protein* Per Cent.	Ash Per Cent.	Solids Per Cent.
Pfeiffer[85]	0.75-9.05	4.22- 7.65	1.049-3.04	0.104-0.446	8.23-15.559
Johannessen and Wang[86]	2.7 -4.6	5.9 - 7.8	0.9 -1.3	.....	
V. and J. S. Adriance[87]	1.31-7.61	5.35- 7.95	0.23 -2.60	0.09 -0.28	9.19-15.31
Guirand[88]	1.75-6.18	6.7 - 7.7	0.85 -1.4	0.10 -0.27	11.2 -16.3
Camerer and Söldner[89]	1.28-5.77	5.35- 7.52	0.82 -1.86	0.11 -0.36	9.41-14.11
Schlossmann[90]	1.65-9.46	5.2 -10.90	0.56 -3.4		

* Nitrogen times 6.25.

the mother is underfed.[91] If more fat is given in the diet of such an underfed woman, the fat in the milk will increase up to a certain point. If, however, large amounts of fat are given to women who already have sufficient quantities of fat in the food, there is only a temporary increase in the fat in the milk in spite of the excessive fat in the diet.[92] Czerny and Keller[1] conclude that the milk of nursing mothers cannot be permanently influenced by the food, except in those instances in which they do not get sufficient food, i. e., when they are partially starved. The

85. Pfeiffer: Verhandl. d. II Vers. d. Gesellsch f. Kinderh. in Wien, 1894, p. 131.

86. Johannessen and Wang: Ztschr. f. Physiol. Chem., 1898, xxiv, 499.

87. Adriance, V. and J. S.: Arch. of Pediatrics, 1897, xiv, 27.

88. Guirand: Thèse de Bordeaux, 1897.

89. Camerer and Söldner: Ztschr. f. Biol., xli, N. F., 18, p. 280.

90. Schlossmann: Arch. f. Kinderh., 1900, xxx, 324.

91. Engel and Plaut: München. med. Wchnschr., 1906, liii, 1158.

92. Albert: Ref. Malys. Jahresb. f. Thierchemie, 1899, xxix, 253; Henriques and Hansen: Jahresb. f. Thierchemie, 1899, xxix, 68.

quantity of the milk cannot be increased at will by increasing the amount of food or drink. There are a few instances on record in which the addition of sugar to the diet of a nursing woman has increased the amount of sugar in the milk. Such an increase is, however, by no means the rule (see lactose).

GALACTAGOGUES

Schafer and MacKenzie[93] found that the posterior lobe of the pituitary body of the ox and the corpus luteum of sheep both act as galactogogues when injected into cats and dogs. Hammond[94] found that the injection of pituitary extract into lactating goats increased the amount of milk for twenty-four hours. The amount decreased below the normal during the next twenty-four hours, however, so that the average of the two days was the normal amount. Gavin[95] did not find the pituitary extract affected the quantity of milk in cows. MacKenzie and others[96] believe that the mammary gland can be stimulated by the posterior lobe of the pituitary body, the pineal body and the corpus luteum. The action of the former is supposed to be the most powerful. Inhibitory substances are said by some observers to be produced by the fetus, placenta, spleen, pancreas, adrenals and thyroid. Aschner and Grigori,[97] on the other hand, say that the pulp of placenta or of the fetus, or their watery extracts, cause a true secretion of milk in virgin animals, and that the body which causes this secretion is (contrary to Starling's contention) destroyed by alcohol and heat. Basch[98] reports that substances present in the placenta when injected into animals will bring back the secretion of milk after it has stopped. Wolf[99] injected milk into nursing women and found that there was an increase in the amount of milk secreted. Chatin and Rendu[100] repeated Wolf's work with eight women. They gave thirteen injections of milk with the result that in eight instances the curve of milk secretion remained stationary or became slightly lowered. In the five remaining instances, there was a slight increase in the amount of milk secreted after the injection of milk. This increase was, however, always in association with other factors, such as change in the number of nursings, or a greater demand on the part of the infant. They believe that the latter were the cause of the increase and not the former.

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93. Schafer and MacKenzie: Proc. Roy. Soc., London, (B) 1911, lxxxiv, 16.
94. Hammond: Quart. Jour. Exper. Physiol., 1913, vi, 311.
95. Gavin: Quart. Jour. Exper. Physiol., 1913, vi, 13.
96. MacKenzie: Quart. Jour. Exper. Physiol., 1911, iv, 305; Ott and Scott: Therap. Gaz., 1911, xxxv, 689. (Experiments in goats.)
97. Aschner and Grigori: Arch. Gyn., xciv, No. 3. (Guinea-pigs were used.)
98. Basch: München. med. Wchnschr., 1911, lviii, 2266.
99. Wolf: Zentralbl. f. Biochem. u. Biophys., 1913, xiv, 224.
100. Chatin and Rendu: Lyons méd., 1912, cxviii, 161.

There is much evidence to show that substances secreted in the ovary cause the growth of the breast glands at puberty. Cramer[101] believes that it has no influence on the hyperplasia of pregnancy, while Basch,[98] on the other hand, attributes the increase in size of the breast glands to a secretion in the ovary. The blood of a pregnant animal injected into a lactating animal has no influence on the secretion of milk.[102] Engel concludes that there are no artificial means of increasing the secretion of milk.

FOREIGN BODIES IN HUMAN MILK

Certain drugs have been proved to be excreted in human milk after they have been taken by the mother, but these are present only in traces. They are potassium iodid, sodium salicylate, antipyrin, mercury,[19] aspirin, calomel, arsenic, bromids,[103] urotropin,[104] and to a certain extent those bodies which are soluble in fat, such as the iodinized oils.[19]

Alcohol is found in human and cow's milk in minimal amounts after the ingestion of very large amounts, but not after the taking of small amounts.[105] It is possible that opium, in the form of morphin, and atropin may be excreted in human milk, since it has been shown that they go over into the milk of animals.[1] They have not as yet been found in human milk.

Salvarsan injected into the syphilitic mother is excreted in the milk and after such treatment the syphilitic suckling frequently shows remarkable improvement; in some instances the infant has suddenly died, so soon after the institution of treatment that death seemed to result from treatment.[106] It is evident that such treatment may not be entirely free from danger.

INFLUENCE OF VARIOUS PHYSIOLOGICAL AND PATHOLOGICAL CONDITIONS ON THE SECRETION OF MILK

1. *Nervous Impressions.*—"Fright, grief, passion, excessive sexual indulgence, or any great excitement may entirely arrest the secretion, or if not arrested the milk may be so altered in composition as to make the child actually ill." (Holt.) Although such phenomena have been observed clinically, there are no chemical observations which tell

101. Cramer: München. med. Wchnschr., 1909, lvi, 1521.
102. D'Errico: La Pediatria, Abstr. in Jahrb. f. Kinderh., 1910, xxii, 504.
103. Bucura: Ztschr. f. Exper. Path. u. Therap., 1907, iv, 398.
104. Schmid and Schröter: Zentralbl. f. d. ges. Physiol. u. Path. Stoffwechsels, 1910, v, 129; Rieder: Monatschr. f. Kinderh., 1912, xi, 80.
105. Voltz: Biochem. Ztschr., 1913, lii, 73.
106. Jesionek: München. med. Wchnschr., 1911, lviii, 1169; Jeanselme: Ann. de gynéc. et d'obst., 1911, 2 Ser., viii, 394; Wolbarst: Am. Medicine, 1911, xvii, 486.

exactly what the chemical changes are under such circumstances, except those given by Rotch.[107]

2. *Menstruation.*—Rotch[107] gives the illustration, shown in Table 11, of a case in which the milk was examined during and after menstruation.

TABLE 11.—EFFECT OF MENSTRUATION ON BREAST-MILK

	Fat	Lactose	Protein	Salts	Water
Second day of menstruation; child's stools loose. Per cent.	1.37	6.10	2.78	0.15	89.60
Seven days after menstruation; bowels regular. Per cent.	2.02	6.55	2.12	0.15	89.16
Forty days later; child gaining rapidly. Per cent.	2.74	6.35	0.98	0.14	89.79

Bendix[108] examined the milk of eight women before, during and after menstruation. He concluded that such variations as he obtained were not outside of the normal physiological limits.

Uremia.—Finizio[109] studied the protein content of human milk and found that it increased only in nephritis and mild uremia (see residual nitrogen). Thiemich[110] concluded, after reviewing the literature, that this increase did not affect the nursing infant so long as the quantity of the milk and the health of the mother were normal.

Beriberi.—The milk of mothers with beriberi paralyzes the heart of frogs quicker than does Ringer's solution.[111] Clinically, such milk is dangerous for the infant and causes the disease. The poisons are probably toxins. They are excreted in greater quantities in the milk, if the mother is constipated.[112]

Bile.—Bile has been detected in the fat of the milk of a patient who developed jaundice after each confinement. The fat contained urobilin and small amounts of bilirubin, while there were no bile components in the aqueous liquid.[113]

DIFFERENTIATION OF HUMAN FROM OTHER MILKS

Umikoff's Reaction.—When 5 c.c. of milk are warmed on a water bath at 60 C. with 2.5 c.c. of a 10 per cent. solution of ammonium hydrate for from fifteen to twenty minutes, a reddish violet color appears if human milk is used, while there is no change with cow's milk.

Davidsohn's Reaction.—See fat-splitting ferment.

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107. Rotch: Pediatrics, Philadelphia and London, 1901, p. 144.
108. Bendix: Charité-Ann., 1898, xxiii, 412.
109. Finizio: Pediatria, 1908, vi, 401.
110. Thiemich: Monatschr. f. Geburtsch. u. Gynäk., viii, 521; ix, 504.
111. Guerrero and Cavieres: Bull. Manila Med. Soc., 1912, iv, 167.
112. Inagaki and Nakayama: Abstr. in Brit. Jour. Dis. Child., 1910, vii, 467.
113. Marek: Pharm. Weekblad., 1907, xliv, 153.

Moro's Reaction.[114]—Moro found that a 1 per cent. aqueous solution of neutral red turns human milk yellow and cow's milk purple. The addition of 1 drop of the stain to a teaspoonful of drawn breast-milk changes it to a reddish purple at once, if the milk has been kept too long and is unfit for use.

Bauer's Reaction.[115]—Bauer found that the addition of 1 drop of a 0.25 per cent. aqueous solution of neutral blue sulphate (Grubler) to from 2 to 3 c.c. of human milk turns the milk violet-blue. When added to cow's milk it turns it greenish-blue. When about five times as much ether is added and the mixture is shaken violently, the color is extracted from human milk but persists in cow's milk.

Tugendreich's Reaction.[116]—Equal amounts of a 1 to 2 per cent. aqueous solution of silver nitrate and milk are mixed, shaken and quickly boiled for three minutes. Human milk changes in color to coffee-brown or brownish-violet, while cow's milk does not.

FERMENTS (ENZYMES)

A great deal of importance has been attached to the ferments or enzymes of milk, especially in the discussions as to whether raw or boiled milk are the more digestible for infants and in connection with the diseases of metabolism, such as scorbutus and rachitis.

The study of the ferments is open to error because of the presence of bacteria in milk. It is almost impossible to obtain a truly sterile milk and to keep that milk sterile for any length of time. The use of toluol or chloroform to keep the milk sterile may modify or destroy the enzymes, while sterilization by heat destroys the enzymes. Since the action of bacteria may cause all the phenomena produced by the ferments in milk, the action of bacteria must always be excluded.

1. *The Proteolytic Ferments.*—(a) Casease has the property of converting casein into soluble albumin.[117] It is found in human and cow's milk.

(b) Pepsin and Trypsin: Both of these ferments are supposed to be present in cow's and human milk (Spolverini[118]), the one acting in acid media and the other in alkaline surroundings. Other investigators[119] could not convince themselves that there were any such ferments in demonstrable quantities. The proteolytic ferments, according to Freeman[120] are not affected by heating for one-half hour at 65 C.

114. Moro: München. med. Wchnschr., 1912, lix, 2553.
115. Bauer: Monatschr. f. Kinderh., 1912-13, orig. xi, 474.
116. Tugendreich: Berl. klin. Wchnschr., 1911, xlviii, No. 1, p. 224.
117. Raudnitz: Ergebn. d. Physiol., 1903, ii.
118. Spolverini: Arch. de méd. d. Enf., 1901, iv, 705.
119. Moro: Jahrb. f. Kinderh., 1902, N. F., lvi, 391; Hippius: Jahrb. f. Kinderh., 1905, lxi, 365.
120. Freeman: Jour. Am. Med. Assn., 1907, xlix, 1740.

(149 F.) or for one hour at 60 C. (140 F.). They are destroyed by boiling.

(c) Fibrinogen: Schlossmann[121] observed that human milk caused the coagulation of the hydrocele fluid from a young infant, while cow's milk did not. This observation was subsequently confirmed.[122] It was shown that this ferment is not destroyed by heat[123] and that it is sometimes found in cow's milk.[124]

2. *Carbohydrate Splitting Ferments.*—Amylase[125] has the power of splitting starch into dextrin and of continuing the process until a very little of it is converted into maltose.[126] This ferment is present in human milk. According to some investigators it is not present in cow's milk. Others[127] using different methods, always find it in cow's milk. The action of amylase is increased by the addition of peroxid of hydrogen.[128] It is destroyed at the temperature of 75 C. (167 F.), perhaps at a somewhat lower one. It appears to pass into the whey when the casein is precipitated.

A disaccharid-splitting ferment has been reported in cow's milk which is capable of splitting lactose; it may also be present in human milk.[129] It is not changed by heating for one-half an hour at 65 C. (149 F.) or for one hour at 60 C. (140 F.), but is weakened by heating for a short time at 70 C. (158 F.) and is destroyed at 75 C (167 F.).[120]

3. *Fat-Splitting Ferment.*—This ferment decomposes neutral fats into fatty acids and glycerin.[130] It is found in both human and cows' milk. This ferment in human milk breaks tributyrin into butyric acid in a very few minutes, but in cows' milk only after many hours. This test may be used to differentiate raw human milk from boiled human milk, and raw and boiled cows' milk.[131] The ferment is, therefore, present in relatively large amounts in human milk, but only in traces in cows' milk. Heating to 60 C. (140 F.) does not affect it, while 64 C. (147.2 F.) destroys it.

Salol-Splitting Ferment.—It was found that human milk had the power of splitting salol. This power was not destroyed by heating to

121. Schlossmann: Verhandl. d. Eighteenth Versamml. Gesellsch. f. Kinderh. Hamburg, 1901.
122. Moro: Wien. klin. Wchnschr., 1902, xv, 121.
123. Moro and Hamburger: Wien. klin. Wchnschr., 1902, xv, 121.
124. Bernheim-Karrer: Zentralbl. f. Bakt., 1902, xxxi, 388.
125. Diastase, zymase, diastatic ferment.
126. Bechamp: Compt. rend., Acad. d. sc., 1883, 96.
127. Konig: Milchwirtschol: Zentralbl., 1907, iii.
128. Lagane: Compt. rend., Acad. d. sc., 156, 1941.
129. Stoklasa: Arch. f. Hyg., 1904, l, 165.
130. Marfan and Gillet: Monatschr. f. Kinderh., 1902-3, l, 57; Moro (loc. cit. Note 119); Hippius (loc. cit. Note 119).
131. Davidsohn: Ztschr. f. Kinderh., 1913, viii, 14.

100 C. (212 F.). Further investigation showed that this phenomenon was not due to a ferment, but was purely chemical. Salol is split in an alkaline medium of the same alkalinity as human milk. When cows' milk is brought to the same grade of alkalinity it also will split salol.[132]

4. *Oxydase and Reductase.*—1. Superoxidase: Superoxidase is the name given to the ferment which reduces peroxid of hydrogen into water and oxygen. It acts best at about 37 C. (98.6 F.) and is destroyed at about 68 C. (154.4 F.). During centrifugalization it rises with the cream.[133] There is a large amount both in human milk and cows' milk.

2. Peroxidases: Peroxidases hasten the oxidation of such bodies as tincture of guaiac. They pass into the cream during centrifugalization and in fractional precipitation are precipitated along with the globulins.[134] There is no definite temperature at which this enzyme is destroyed, because the rate of heating modifies the results.[135]

3. Reductase: When reductase comes in contact with sulphur and water it converts the sulphur into the corresponding hydrids;[136] it also reduces methylene blue[137] and decolorizes Schardinger's reagent.[138] It is stronger in cream than in skimmed milk[138] and is precipitated with the casein. It is found in both human and cows' milk. Its action with Schardinger's reagent[139] is used in differentiating raw from boiled milk. Heating milk to between 70 C. (158 F.) and 80 C. (176 F.) stops the reaction. Reductase is most active between 40 C. (104 F.) and 55 C. (131 F.).

TRANSMISSION OF TOXIC BODIES AND IMMUNITY THROUGH MILK

1. *Toxins.*—Sonnenberger[140] concluded from his investigations that milk is not only a secretion but an excretion and that, therefore, many vegetable poisons in the food of animals may go over in the milk. Among these poisons are alkaloids, glycosids and amids, as well as volatile and ethereal oils, and dibasic organic acids.

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132. Demoulieres: Jour. de pharm. et chim., 1903, xvii; Miele and Willen: Compt. rend., Acad. d. sc., 1903, cxxxvii.

133. Hecht and Friedjung: Arch. f. Kinderh., 1903, xxxvii, 177.

134. Raudnitz: Pfaundler & Schlossmann: Diseases of Children, Philadelphia and London, 1908, i, 308.

135. Van Eck: Chem. Weekblad, viii, 692, ref. Chem. Abstr., Jan. 10, 1912.

136. Rey: Pailhade quoted from Pozzi-Escot: Etat actuel sur les oxydases et reductases, Paris, 1902.

137. Pozzi-Escot (see 136).

138. Smidt: Hyg. Rundschau, 1904, xiv, 1137; Hecht: Arch. f. Kinderh., 1904, xxxviii, 349.

139. Five c.c. saturated alcohol solution of methylene blue, 5 c.c. formalin, 190 c.c. water.

140. Sonnenberger: Therap. Monatschr., 1901, xv, 6; Sonnenberger: Seventy-first Naturforschersamml., München., 1899.

Toxins may be formed as the result of the metabolism of certain bacteria, may be produced by plants, or may come from the secretions or body components of certain animals.

2. *Antibodies.*—Ehrlich[141] was the first to show that immunity could be transmitted to the infant through the milk. The fact that breast-fed infants seem to be less liable to such diseases as measles, scarlet fever, mumps and typhoid fever is used by many as an argument that immunity is transmitted through the breast-milk.

3. *Antitoxin.*—It has been shown that in animals immunity to the bacillus of anthrax and the pneumococcus is transmitted by the mother to the young. It is impossible to say, however, whether this immunity is transmitted through the milk or is acquired during intrauterine life.[142] Ehrlich[141] concluded from his researches that artificial immunity can only come through the milk of the mother. When a mouse which was born of a normal mother, which was not immunized, and was fed by a mouse immunized with antitoxin, the suckling developed immunity. The amount of antitoxin that passes from the mother through the milk to the suckling is between one-fifteenth and one-thirtieth of the total amount in the mother, depending on the amount of lactalbumin and globulin that her milk contains.[143] It was impossible to immunize the human infant by feeding it with horse antitoxin, but when its own mother or the wet-nurse was immunized with horse antitoxin the immunity was transferred through the milk to the nursing infant even as early as the fourth week of life.[144] Immunity can, therefore, be transferred by way of the milk or albumins of the same species, but not by those of another species.

4. *Agglutinins.*—The same question comes up in studying the agglutinins as in the case of the antitoxins as to whether the property of agglutination is acquired during intrauterine life or passes through the milk.

The evidence that it may be transferred by the mother through her milk to the infant is in part positive and in part negative. Romer,[145] after summing up the literature, concludes that agglutinins may be transferred in the milk. The agglutinins in the milk of the mother are more easily absorbed from the infant's gastro-intestinal canal than those in the milk of animals.

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141. Ehrlich: Ztschr. f. Hyg. u. Infectionskr., 1892, xii, 183.

142. Chauveau: Ann. de l'Inst. Pasteur, 1888, ii, 66; Klemperer: Arch. f. Exper. Pathol. u. Pharm., 1892-93, xxxi, 356.

143. Brieger and Ehrlich: Ztschr. f. Hyg., 1893, xiii, 336; Brieger and Cohn: Ztschr. f. Hyg., 1893, xv, 1; Wassermann: Ztschr. f. Hyg., xviii; Ehrlich and Wassermann: Ztschr. f. Hyg., 1894, xviii, 235; Romer: Berl. klin. Wchnschr., 1901, xlvi, 209; Kayser: Ztschr. f. klin. Med., 1905, lvi, 17.

144. Salge: Jahrb. f. Kinderh., 1904, lx, 1.

145. Romer: Sommerfeld's Handbuch der Milchkunde, Wiesbaden, 1909, p. 492.

5. *Bactericidal Substances.*—The fact that the blood of infants that are nursed at the breast contains stronger bacterial substances than that of those fed on the bottle[146] is evidence in favor of these substances being carried in the milk, in spite of the fact that they cannot be demonstrated in the milk itself.

6 *Hemolysin.*—Hemolysin has recently been demonstrated as a normal constituent of the different kinds of milk.[147] It is absent from colostrum in the majority of cases tested on the second day postpartum.[148] *Hemagglutinins* are found in human milk which react differently toward the blood corpuscles of different species of animals.[149]

7. *Opsonin.*—The milk is poorer in opsonins than the blood serum of the mother[150] while the colostrum contains more than the milk.[151]

8. *Hypersensibility* (sensitization) toward various poisons and albumins may pass over in the milk to the infant and be absorbed.[152]

146. Moro: Jahrb. f. Kinderh., 1902, lv, 396.
147. Pfaundler and Moro: Ztschr. f. Exper. Pathol. u. Therap., 1907, iv, 451.
148. Kolff and Noeggerath: Jahrb. f. Kinderh., 1909, lxx, 701.
149. Zubezycki and Wolfsgruber: Deutsch. med. Wchnschr., 1913, xxxix, 210.
150. Turton and Appleton: Reference, Deutsch. med. Wchnschr., 1907, xxxiv.
151. Tunnicliff: Jour. Infect. Dis., 1912, xi, 347.
152. Otto: München. med. Wchnschr., 1907, liv, 1665.

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RECENT PROGRESS IN INFANT WELFARE WORK

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Infant welfare work in this country, in the sense of consistent scientific investigation and the application of well defined principles, has only existed during the last few years. Ten years ago efforts directed toward the welfare of babies and children were largely sporadic and disjointed. The results of such work were inappreciable. It was only with the continuous application of the principles of prevention that progress has been made and results can be said to have been accomplished.

Probably the most striking example of recent methods lies in regarding the mother as the object of attack in the problem of reducing infant mortality. A. Keller has stated, "The protection of motherhood is the best protection on infants. The care of the mother is inseparably bound up with the protection of infancy." This is practically the key note of modern methods of infant welfare work, whether it be the real mother of the child or the foster mother. Of recent years the prevention of prematurity and congenital debility, the prevention of diarrheal diseases, the prevention of all the injurious influences which are responsible for poor health and death among babies, are attempted more and more by means of the education of mothers.

Another important sign of the times is the increasing cooperation existing between various agencies engaged in particular fields of activity all directed toward the welfare of babies. In a word, we may summarize the recent progress in infant welfare work as consisting in prevention through education and cooperation.

Tremendous strides have been made during the past six years. Public authorities are becoming impressed with their responsibility for the protection of infancy. The public at large is becoming interested in the prevention of infant mortality and is not only backing up public authorities in their work, but demanding greater efforts on their part. The United States Government in 1912, established the Federal Children's Bureau. In 1913 this Bureau was allowed an appropriation of $25,000 to carry on its work. This year the appropriation asked for was $165,000. The attempt was made in Congress to cut this down to last year's inadequate amount. Such a flood of protest was received by members of Congress and others that the entire appropriation as originally asked for was finally allowed.

In the brief account of progress which follows there will be many activities which pass unnoticed. It is very much easier in America to

find out what Europe is doing than what we ourselves are doing. Information is scattered through a multitude of unavailable reports of organizations, health departments, etc., and with the exception of summaries of a few activities published in the "Report on Baby Saving Campaigns, a Preliminary Report on What American Cities are Doing to Prevent Infant Mortality" by the Children's Bureau, and the summaries of activities of societies affiliated with the National Association for the Study and Prevention of Infant Mortality published in the Association's Transactions, it is impossible to obtain information in any condensed form.

PUBLIC ACTIVITIES

The first, and only, national activity directed toward child welfare exclusively is the Federal Children's Bureau, founded in 1912, which was instructed by Congress to investigate "all matters pertaining to the welfare of children and infant life." Up to the present time the Bureau has been obliged to limit itself to the collection of information and publishing of a few pamphlets, one of which is on child welfare activities and another, the first of a series of booklets of instruction to mothers. The first of this latter series is a practical guide for the average mother in the hygiene of pregnancy and the preparation for maternity. The second pamphlet, which is in course of preparation, deals with the child during its first two years of life. The Bureau is acting as a source of information to all interested in any phase of infant welfare work and is stimulating the starting of such work in localities where it is most needed.

The only other National Government activity is the Public Health Service, which has published at various times a report on Milk Stations; the Report of the National Commission on Milk Standards; and the booklet on the Care of Children compiled by the National Association for the Study and Prevention of Infant Mortality. The United States has made a beginning.

Under our form of government, most of the actual work must be carried on by state and city authorities. These authorities are becoming more and more awake to their responsibility and the progress which has been made during the last few years is great.

The public health law in New York State, which was passed in 1913, is most far-reaching from the standpoint of infant welfare. This law creates a Division of Child Hygiene in the State Department of Health. For several years past, the Department has been doing good work and the problem of infant mortality has been one of the prominent features in the *Monthly Bulletin.* A very useful booklet on "How to Save the Babies" has been issued and a great many thousand copies distributed throughout the state. The consulting pediatrician to the department, who has now become director of the Division of Child Hygiene, has been untiring in his efforts to further infant welfare work in the state. The

plans of the newly formed division are far reaching. An educational campaign throughout the state is planned, the basis being three traveling infant welfare exhibits. These exhibits will be sent to various parts of the state, especially to the smaller cities. They will be accompanied by specially trained nurses and will be the center of local campaigns to arouse interest in the prevention of infant mortality. Such a campaign is now being carried on at Syracuse, New York. These exhibits will not flit from place to place merely scratching the surface, but will stay long enough to see that some definite work is started and the department plans to keep in touch with each locality so visited and try to see that the work is begun along proper lines.

The report of the commission appointed by Governor Sulzer to investigate the health needs of the state, urged the establishment of an infant welfare station in every town of 10,000 population or over, provided there was a considerable proportion of industrial work in this district. It also urged as a basis for larger industrial towns, one welfare station to every 20,000 population. It recommended that local health authorities be specifically empowered to employ trained nurses to do infant welfare work. The new law does so empower local authorities.

Other states are taking an interest in this work. In Ohio there is a traveling welfare exhibit under the auspices of the State Department of Health and, especially in the south and west, state health departments are active in spreading information and in circularizing their people in regard to the common dangers to infants and the means of combating them.

Infant welfare work by city authorities is also becoming more and more general. Several city departments of health have established divisions of child hygiene as, for example, New York, Boston, Cleveland, Milwaukee. Many cities have started municipal welfare stations. Rochester, N. Y., was a pioneer in this work, having started in 1897 and maintains during the summer months, at the present time, ten stations. In Boston prenatal and general preventive work is being done by the nurses attached to the department's staff. Richmond, Va., Chicago, Philadelphia, Cleveland and many other cities employ nurses who visit all newly reported births. Cooperation between public and private activities is becoming more and more general, especially in smaller localities. The most ideal system which has been worked out in this country is that of Cleveland, O., which will be described more fully under Infant Welfare Stations.

In Europe, almost every government is engaged more or less actively in infant welfare work. The greatest attention is being directed toward the supervision of children deprived of their natural protectors and placed out with foster parents. This includes orphans, dependent children and illegitimate children. Europe in this regard is far ahead of the United States, where there is an almost total failure to safeguard

these children. National laws defining the responsibility of the state and laying down general principles for safeguarding such children exist in Germany, Austria, Hungary, France, Spain, Norway, Sweden, Holland, Roumania, Bulgaria, Russia and many others. In England and Wales, the Notification of Births Act has made possible the very general visiting by health-authorities of all newly-born babies. Out of the 241 urban areas in England and Wales, 183 employ one or more health visitors to visit every newly-born baby. The activities of Spain and Hungary deserve special mention.

In Spain there exists a Superior Council for Child Welfare, whose president is the Minister of the Interior and whose membership consists of the General Inspector of Public Health, the Vice-President of the Royal Department of Health, a member of the Royal Academy of Medicine and representatives of almost every well organized activity in the kingdom. This Superior Council has general oversight over all children under 10 years of age. Their special functions are the supervision and protection of children in the care of foster parents, the supervision and training of midwives, the regulation and supervision of crêches, asylums, hospitals, etc. In addition to, and working with, the Superior Council, there are forty-nine provincial bodies supervising the detailed administration in the provinces and six thousand and more local bodies caring for the detail of the work.

In Hungary there is a most complete and far-reaching system of government welfare work for both babies and older children. The Hungarian system is the result of the law of 1903. This law declares it to be the right of every child in Hungary under the age of 15 years, to care, nourishment, education and a home. If the parents of the child cannot give it what it is entitled to, it is the child's right to receive this from the state. The system itself is so far-reaching and seems theoretically so perfect, that it is worthy of a more or less detailed description. There are seventeen state asylums in various parts of the country which act as the headquarters for this work of caring for children. Each institution is in charge of a medical director. Any person bringing in to the institution a child and declaring themselves unable to properly care for that child, can secure its immediate admission to the institution. An investigation is then made to determine the ability of the parents or guardians, or unmarried mother, to provide for the child. If it is found that it is a proper case, it then becomes a charge of the state.

If the child is sick, delicate, or in need of special care, it is kept in the state institution until it is in fit condition to be sent out. Healthy children are immediately placed under the care of foster parents carefully selected in special localities chosen for the healthy climatic and living conditions. There are 374 of these so-called State Children's Colonies. When boarded out, the children are under the immediate super-

vision of a physician residing in the neighborhood and are constantly watched by the visiting nurse assigned to each district. In the case of infants, if the baby is admitted to the institution, every effort is made to induce the mother to stay with it to nurse the child, the mother receiving support in return for nursing her baby; she also nurses another baby if able. If the nursing mother consents to remain with the child, in most cases she is sent with it to a foster home and while she remains money is paid for her care and she receives necessary clothing, etc., from the state If it is impossible to keep mother and child together, the baby is boarded out with a nursing foster-mother. In 1910, the statistics showed that over 57 per cent. of young babies remained with their mothers. In the year 1910, 3,129 infants were being thus cared for at public expense in the State Children's Colonies. Between $1,500,000 and $2,000,000 were expended for the state care of children in 1910.

In Germany the care of needy and sick children has been developed to a high degree in Charlottenburg. Through a system of public and private cooperation immediate care in case of need or emergency is forthcoming. Dangerous delay due to official red tape is avoided. This protection of the life and health of the child begins before its birth and continues through school age. Every institution is empowered at once, without previous inquiry or without any payment in advance, to receive in case of emergency any child requiring assistance, to be paid for by the authorities. These latter investigate, after the child has been received, and if it is a proper case, its continued care is authorized. A certificate can be obtained from the authorities, giving a woman the right to the services of a midwife for fourteen days and this certificate can be renewed for a further fourteen days if necessary. When immediate financial assistance is necessary, the Guardianship Office is empowered to grant at once small sums to pay for emergency relief. This office also can admit at once any child under its supervision to any city institution. Welfare stations are maintained and are available to any family in Charlottenburg.

A special committee has charge of the care of expectant mothers, providing extra nourishment for them at city expense if necessary. The other children of a pregnant woman may also be admitted to one of the institutions at city cost, if necessary.

There are two leagues which provide workers to take care of the home during the lying-in period. Such help was provided to 899 women in 1910. The various-coordinated activities in addition to those already mentioned, consist in lying-in institutions; home for nursing mothers and their babies; home for mothers with older children where they may leave their children during the day and return to them at night; hospital facilities for sick babies; convalescent home; a thoroughly organized

crêche; home instruction and supervision of every boarded out baby and —when desired—of any baby; and the dispensing of free milk for babies and nursing mothers. The annual expense to the community is about 308,000 marks.

INFANT MILK STATIONS. INFANT WELFARE STATIONS. INFANT CLINICS

There is no phase of infant welfare work which has met with such instant success and which is capable of greater development than the infant welfare center. The history of the development of this activity is an interesting one. Starting twenty years ago in this country as a center from which pure milk, modified according to set formulae supposed to be adapted to the average child at certain ages, without any medical supervision, without any instruction of the mothers, it did not take long to discover that its usefulness was very limited. The purest of milk improperly used, improperly kept, can do an immense amount of harm. These stations, further, without question stimulated artificial feeding from a false sense of security. Further, they taught the mother nothing. Moving to a place where such a milk station was not available, she was as badly off, if not worse off, than before. The milk station of today makes personal instruction of the mother by a physician and by the visiting nurse in the home, the most important element without in any way denying the great importance of clean, pure milk for a baby's food when it is deprived of its natural source of nourishment. Many stations starting in with distributing milk, modified at a central laboratory at great cost, have either given up general modification—only resorting to it in special cases—and dispensing pure whole milk to be modified by the mother under supervision, or else have given up entirely the dispensing of milk. This has been made possible by the great improvement in recent years in the milk supply of our cities. Starting, as I have said, with the station for dispensing pure modified milk, probably the most striking example of the development of the milk station is to be found in Cleveland, Ohio. Nowhere else in the world has such a perfect system been devised and carried out as in Cleveland.

In 1902, the Milk Fund Association was started to supply modified milk to babies who were brought to the central station, examined by physicians and a formula prescribed. There was little attention given to the instruction of the mother and no attempt at home visiting. In 1904 this association procured a farm where they produced their own certified milk and discontinued the wholesale distribution of modified milk, substituting therefor whole milk distribution. In 1906, the Milk Fund Association and the Visiting Nurse Association cooperated in forming an infant clinic. The consultations were carried on at this clinic as before, but in addition, home visiting for instruction and advice was carried out by the visiting nurse attached to the clinic. The results of this

work seemed so promising that, in December, 1906, the Babies' Dispensary and Hospital was organized and took over this work. The Milk Fund Association continued to supply the milk; the new organization carried on a clinic in a remodeled frame house on property which they had bought. The following year, cooperation having been so successful and all concerned being so anxious to accomplish their definite purpose, the Milk Fund Association amalgamated with the Babies' Dispensary and Hospital, turning over all their property to the latter and urging their supporters to transfer their interest to the new organization. So great was the immediate success that branch dispensaries, known as the Babies' Prophylactic Dispensaries, were founded, the central dispensary caring for the sick babies, the branch dispensaries for the well ones.

By 1908 six such branches had been established. The same general system of supervision, instruction, etc., was in force in all the dispensaries, owing to their being under the charge of one medical director and one supervising nurse. In addition, before working in the branch dispensaries, each physician and nurse was required to serve a certain length of time in the central dispensary, thereby becoming acquainted with the methods in vogue. The clinics are held in the branch dispensaries in the morning. The physicians examine the babies and order their food. If the baby is sick, it is referred to the central dispensary, which is open for consultation in the afternoon, thereby preventing delay in handling sick cases. At the end of the consultation at the branch dispensary, the nurse telephones to the central dispensary the amount of milk needed. Most of this milk is dispensed as whole milk, modification only being done at the central plant in cases in which dense ignorance, illness of the mother, or some other cause makes it impossible for home modification to be carried out. From the central dispensary, the milk is distributed by automobiles to the distributing stations which are located in drug stores, groceries, etc. In 1910, a dispensary building was erected, containing large consultation rooms, lecture room, milk laboratory, etc.

In 1911 the city of Cleveland appropriated $10,000 for infant welfare work and established five prophylactic dispensaries of their own. They also formed a department of child hygiene and made the medical director of the Babies' Dispensary and Hospital its director and the superintendent of the dispensary its superintendent of nurses. At the end of the year, five of the branch dispensaries were turned over, the city also founding two more of its own, making thirteen branch dispensaries. These prophylactic dispensaries, as already mentioned, care only for the well cases, sick cases being sent to the central dispensary, which alone is maintained by the Babies' Dispensary and Hospital.

This, however, is not all the work done by this organization in cooperation with the health department. The entire time of one visiting nurse has been devoted to the prevention of blindness, she calling on all

babies as soon as possible after their birth is reported. This work has recently been transferred to the health department, who now have three nurses spending their whole time for this purpose.

Another nurse spends her whole time building up a system for boarding out babies. It is based on the European system of one baby in a home. Homes are carefully investigated and a list is kept. When a baby needs to be boarded out, it is placed in one of these homes and the nurse keeps constant supervision and the foster-mother is required to bring the baby to the dispensary for observation.

Another nurse connected with the institution is demonstrating to the department of education the possibility of introducing the teaching of infant hygiene in the grammar schools. This has met with great success so far, the girls taking a great interest and the plan proving practicable.

The final step in the development of this wonderful organization in Cleveland has been the appointment of the medical director as professor of pediatrics in the Western Reserve University. Dr. Gerstenberger, the director, succeeded in having eight hours placed in the compulsory curriculum of the senior year in the medical school for practical training in social medicine pertaining to infant welfare work.

The Babies' Dispensary maintains the most cordial cooperation with all other activities in Cleveland. There is apparently the utmost harmony everywhere. As an example of this it may be mentioned in passing that in Cleveland almost all of the organizations doing general welfare work and appealing to the general public for contributions, have united into the Cleveland Federation for Charities and Philanthropy for the purpose of obtaining funds for their work. The federation solicits funds for all these organizations for their current expenses only. For special funds, the federated organizations are at liberty to make special appeals after consultation with the board. Any contributor may select the organizations he wishes to contribute to, or may make a general contribution which is distributed by the governing board of the federation according to the needs of the organization. It is interesting to note that while this federation has only been in existence about a year, the increase in the subscriptions received has been nearly 70 per cent. and that the subscriptions from the previous year's subscribers have increased over 57 per cent.

Of the value of infant welfare stations in reducing infant mortality there can be no doubt. In 1911 the New York Milk Committee carried on a vigorous campaign for the reduction of infant mortality, maintaining thirty-one milk stations in the most congested districts of the city, cooperating with the health department and several other organizations in making a demonstration which would convince the city that money spent for this purpose was well spent. In their report on the result of this work, it is stated that between June 1 and November 1, 5,379 children

under 1 year came under their care. The milk stations confined their activities to certain well defined districts. The death rate per thousand enrolled babies, however short their period of attendance, whether they died under the supervision of the stations or not, was 26.9. The general death rate of babies for these same districts during the same period, based on the total number of births in the district for the twelve months preceding November 1, was 53.2.[1] While there is of course possibility of considerable error in interpreting these figures, the difference is so striking that the general result cannot be questioned. Moreover, the milk committee's report shows that over 25 per cent. were sick on enrollment at the station.

As stated, the purpose of this work was to demonstrate the value of infant welfare stations in upholding the intended request of the department of health for an extension of this work by the city. As a result, the financial authorities granted money for fifty-five stations for the department of Health in 1912.

In 1912 the Visiting Nurse Association of Bridgeport, Connecticut, carried out the same plan, establishing a demonstration center which was so successful that the city has since founded two.

The extension of infant welfare work in this country has been enormous. In 1910 the Public Health Service of the United States Government published an article on milk station activities in the United States. They were able to obtain data concerning forty-three stations in thirty cities of over 50,000 population. I have data concerning 204 welfare stations in thirty-nine cities and small towns. In New York state alone, there are ninety-nine stations, eighty of which are known to have been established in 1911 or later.

The tendency has been everywhere to place most emphasis on trained supervision and educational work. At the outset these stations were open only during the summer months, the idea being to reduce the most obvious cause of infant mortality, summer diarrhea; but it has become more and more evident that to accomplish definite, permanent results, the work must be kept up all the year round, with perhaps special activity during the summer months. In New York city, for instance, in the stations of the city department of health during the winter months, the clinics are held once or twice weekly; in the summer in many stations they are held every day and the force of nurses is greatly increased.

Not only have the infant welfare stations increased in number and activity in the large cities, but they are also showing their value in small towns. The Diet Kitchen of the Oranges maintains two such stations which are doing excellent work, consisting in weekly consultations at headquarters, home instruction, prenatal work, "little mothers" classes and the distribution of milk for babies and for nursing mothers. Also

Hastings-on-Hudson, with a population estimated in 1913 at 5,380, has established a welfare station. Everywhere maternal nursing is being emphasized and urged with utmost vigor.

In Europe the infant welfare station had its origin. It is stated that Dr. Solaris established such a center in Barcelona in 1890. This was before Budin established his first *Consultation des Nourrisons* in Paris. France, however, was the leader in developing these stations and reports indicate that at present there are more than 500 in that country. They are spread broadcast all over Europe, some maintained by municipal authorities, some by private, some jointly by the two. In Germany there are 555 in 345 localities, mostly maintained by municipal authorities; in Belgium 77, thirty of which have been founded since 1910; in Sweden 23; Norway 3; Austria 8; Holland 11; Roumania 8; Switzerland 6; Bulgaria 1; Russia 46.

In Germany stations where milk is distributed are the exception, although there are several which have their own dairy. They are almost without exception well run and the importance of scientific medical care is accentuated. In fact, most of the infant welfare work in Germany is due to the initiative and active interest of the medical profession.

Another interesting phase of the work in Germany is the interest being taken by industrial concerns in infant welfare work, of which more will be spoken later. Three manufacturing establishments maintain infant consultations for their workers. Two of them pay nursing premiums, either in money or in kind, or both. One of these concerns in 1910 paid 4,135 marks for this purpose and also provided extra food for the nursing mother.

In Europe the milk problem is a serious one, and in certain places experiments are being made using dried milk for infant food. There are two stations in Brùges where only dried milk is used. In England there are several.

THE PREVENTION OF INFANT MORTALITY DURING THE FIRST WEEK OF LIFE

It has been known for many years that the mortality during the first week of life is very high. In this country up to 1913, we could only estimate roughly what this mortality was. In 1913, however, the Bureau of the Census for the first time published in "Mortality Statistics for 1910" detailed tables of mortality at various ages under 1 year. During this same year the volumes for 1911 and 1912 also appeared. A study of these figures shows that the deaths under 1 year of age in the registration area of the United States had fallen in 1912, 6,918, or nearly 4.5 per cent., from figures of 1910. Further study shows that there was an actual increase of 5,670 deaths under one week of age in 1912 as compared with 1910, an increase of over 15.6 per cent. The registration area in 1912 included 63.2 per cent. of the population as against 58.3 per cent.

in 1910. The actual increase in the population to which these figures apply is estimated by the Bureau of Census as 6,583,237, or 12.2 per cent. over the population in 1910. It is thus evident that the mortality during the first week of life is increasing in the United States, while that at ages from 1 week to 1 year has diminished. In 1910, 23.5 per cent. of all deaths under 1 year occurred during the first week of life, while in 1912 the proportion had increased to 28.5.

It is to combat this excessive and increasing mortality during the first days of life that special efforts are now being organized. In the census figures for 1912 nearly 64 per cent. of the deaths under 1 year are ascribed to premature birth and congenital debility; they must therefore be caused by conditions acting on the child through the mother and must be attacked by methods directed toward the pregnant woman. Probably the first consistent effort directed toward so-called prenatal prevention was carried on by the New York Association for Improving the Condition of the Poor. In the course of their regular relief work, wherever a pregnant woman was found by one of their visitors, a special nurse was sent to visit the mother and advise her concerning the proper care of herself and the importance of maternal nursing. When the baby was born opportunity was given her to have a rest at its mothers' home, "Caroline Rest," at Hartsdale, N. Y. Mother and child, together with the younger children if necessary, were taken to this institution, which has room for forty mothers and their babies. The mother was taught how to care for her baby in the best way and given practical instruction in those phases of mothercraft in which she was most lacking. This work is still being continued by the association and is being at present greatly expanded.

In 1908, the pediatric department of the New York Outdoor Medical Clinic undertook the prenatal supervision and instruction of all women applying at the obstetrical department for obstetrical care.

In 1909, the Committee on Infant Social Service of the Women's Municipal League of Boston, organized their experiment along these lines. Pregnant women are visited once every ten days, oftener if necessary, by a specially trained visiting nurse. They are instructed in the general hygiene of pregnancy, preparation for confinement, the value of maternal nursing both to mother and child, and taught how to prepare themselves to perform this function. The urine is examined at each visit by the nurse and the blood-pressure is also taken. The work is somewhat limited in its field, owing to the fact that the better class of poor mothers are sought out. The attempt is made to make the work as nearly self-supporting as possible, although no suitable case is refused on this ground. Also only women who are to be under the care of physicians or maternity hospitals are accepted. The committee formerly carried on their work after the baby was born, but recently have given up this part of the work. The statistics, as given for the period April 15, 1909 to October 15, 1913,

show a stillbirth rate of 27.7 per thousand based on 1,487 births living and dead. Dr. Davis, vital statistician of the Boston Department of Health, states that the stillbirth rate in Boston as a whole has varied between 33.1 and 44.7 during the past twenty years.

In 1911, the New York Milk Committee undertook an experiment along similar but somewhat broader lines. The effort was made to determine what could be accomplished in reducing the stillbirth rate and the mortality rate under 1 month by intensive prenatal work among the poorer classes of the people. Districts were selected in various parts of the borough of Manhattan, where conditions of living were at their worst, where the ignorant midwife and the unskilled physician were most abundant. Each district was in charge of a special trained nurse who made visits every ten to fourteen days. The general system of instruction and advice was the same as that mentioned in Boston. The urine was examined, but the blood-pressure was not taken. Every effort was made to secure the birth of a full term baby and prevent excessive work in the last weeks of pregnancy. Through the cordial cooperation with the relief organizations in New York it was possible in many cases to secure much needed rest for the mother before her confinement. The best possible care at the time of confinement was urged, but if the woman was determined to have a midwife attend her the case was all the more carefully watched and advised on this account. Among the Italians and Hebrews in New York, who constituted a very large proportion of the women under supervision, a midwife alone will be considered. After the birth of the baby, mother and child were visited until the baby was a month old—longer in special cases—by which time it was possible to transfer both to the care and supervision of the nearest milk station.

From August 1, 1911 to November 30, 1913, 2,644 women were cared for. The results were as follows:

Stillbirth rate	39.8 per 1,000 births
Deaths of babies under 1 month	27.9 per 1,000 living births

For comparison, rates are given for the borough of Manhattan for the same period:

Stillbirth rate	47.5 per 1,000 births
Deaths of babies under 1 month	40.0 per 1,000 living births

In the figures for stillbirths, those of the supervised women, are based on the definition of a stillbirth as "the loss of the product of conception at any period of gestation." A very considerable number occurred early in pregnancy and would not be included as a rule in the general statistics of the city.

Still another form of activity looking toward prenatal prevention of infant mortality is the work being done by lying-in hospitals,

partly through out-patient departments. In St. Louis the social service department of the Washington University Hospital has carried on such service since 1912. For the year ending May 1, 1913, they report 334 cases followed during pregnancy and for one month after confinement. These are all cases applying to the dispensary for complications of pregnancy or to arrange for care at the time of confinement. They are examined and advised in the clinic by the physician and nurse and in 288 of the cases were followed to their homes and further instruction and supervision given there. The results reported are as follows:

	St. Louis	Inst. Cases
Stillbirth rate per 1,000 total births	42.8	30.8
Deaths under 1 month per 1,000 living births	38.0	31.7

Of these cases 169 were white, 165 colored. The difference in the results in the two races is very striking:

	White	Black
Stillbirth rate per 1,000 total births	23.6	36.3
Deaths under 1 month per 1,000 living births	18.5	45.7

All but two of these cases were confined by physicians or in the hospital.

The Pregnancy Clinic of the Boston Lying-In Hospital has been doing this sort of work since 1912. All cases applying to the hospital for out-patient service at the time of confinement, and living within the area controlled by the central establishment, are turned over to this pregnancy clinic. Cases are examined and advised at the clinic and, by an arrangement with the Visiting Nurse Association, an average of three antepartum visits is paid to every patient. Special cases are also visited by the nurse attached to the clinic. The results, as shown by the stillbirth rate are excellent. The rate in Boston was 39.8; for these cases 22.9. Comparing these figures, as well as those of St. Louis, with the figures of the New York Milk Committee, it should be borne in mind that under the supervised cases early abortions are not included as stillbirths in the former.

Prenatal care is being taken up with enthusiasm by a great variety of organizations as a part of their general work. It is also being made a special branch of the work of many. It is of too recent origin, as yet, to have been reported on extensively. There are records, however, of its being carried on in eighteen different cities by twenty-seven organizations.

Another activity which is directed toward the saving of baby lives by promoting breast feeding and maternal care, is being carried on by the Society for Helping Destitute Mothers and Infants in Boston, and by the Sub-Committee for Assisting and Providing Situations in the Country for Mothers with Infants, of the State Charities Aid Association in New York. These two organizations try to keep the nursing mother and her

baby together. Instead of abandoning it to probable death in an institution, places are found where the mother can work and still keep her baby. In 1913 the latter association placed 737 such mothers and babies with the best results. It has cordial relations with the social service workers of the large maternity hospitals, from whom many desperate, unmarried mothers are received. The Boston society placed fifty-nine new applicants during the year.

In Europe for many years there have existed laws requiring, or permitting women to abstain from work for definite periods after confinement and in a few cases before confinement. The period during which it is illegal for a woman to work or for an employer to hire her varies from three weeks to forty days in Roumania and eight weeks in Switzerland. These laws, however, only apply to industrial work and are in many cases weak in that they provide no mechanism for enforcing them, nor any provision for the support of these women when they are unable to earn their living. The industrial insurance laws, which are becoming more general and more wide-spread in their application, are partly meeting this last difficulty. Confinement is classed with sickness, in that the woman is entitled to her pension for periods varying from four to six weeks and in amount varying from one-half the usual sickness indemnity up to one and a half times such indemnity. Here again they are only applicable in most cases to special classes of workers and usually apply only to a married woman.

In Italy the protection of infants and the stimulation of nursing is furthered by a law which requires that every industrial concern employing more than fifty women must provide a room outside of the general factory space, where mothers may nurse their babies. Mothers shall also be allowed a certain amount of time at regular intervals to nurse without any deduction from their wages. Spain and Portugal have followed the example of Italy in this respect. Unfortunately the law is not well enforced and in many places it is claimed that the women will not make use of the facility provided.

In France there is no industrial insurance. In 1892, there was founded in Paris, a *Mutualité Maternelle*. This organization attempted to secure for mothers an opportunity for rest after the birth of the baby, by providing an indemnity sufficient to allow her to cease working. The movement in Paris met with almost instantaneous success and has been copied in many small towns and even in rural communities. In Paris members pay three francs a year. In 1908 there were 26,088 members. The work has become so large that Paris and the Department of the Seine have been divided into some fifty areas each in charge of a local committee. The first year of activity of the association the stillbirth rate was 12 per cent. Since 1906 it has not been above 7 per cent. and has been as low as 4.5. The regulations are very simple. Any woman residing in Paris or the

Department of the Seine enrolls as a member by filling out a blank form, pays her annual subscription and is given some printed instructions and told she must report at once if she becomes pregnant. In connection with the sub-committee are groups of women who visit in the homes after confinement and advise and watch over mother and child. As soon as confinement occurs, the mother receives 12 francs and there is a further subsidy in case she nurses her baby for a definite period. The society keeps careful records and tabulations of the results of its work. In 1908, 90 per cent. of the babies were nursed by their mothers. The mortality during the first year of life was 4.5 per cent., which was equal to one-fifth of the mortality among the working classes in Paris.

Fifty of the districts have provided welfare stations so that mothers may receive instruction all through the first years of the baby's life. Attendance at the station is not compulsory. The figures compiled show that the mortality under 1 month among the babies whose mothers would not, or could not attend the station was 7.5 per cent., while among those attending the conferences it was 3.0 per cent.

The work of the Mutualités has extended into the provinces. One has been founded at Dammarie-les-Lys. This is a village with between 1,600 and 1,700 inhabitants. Women are partly employed in factories, partly in agriculture. Comparing the results of seven years before its foundation with the seven following, there was in the latter period an increase of 24 per cent. in births and a decrease of 50 per cent. in deaths. The mortality under 1 year among the babies of members was just one-half that of the rest of the community, although almost every working woman in the district was enrolled, so that the high rate was among the well-to-do.

Many new features and activities have been added to the primary one. For instance, in Vienne, the society maintains a clothing department, vaccination department, a savings bank in which an account is started for every baby with a deposit of 2 francs, infant welfare stations, free distribution of milk and food to poor mothers who are nursing their babies, hydrotherapeutic institution, medical dispensary, etc. In Germany the "*Säuglingsheim, Charlottenburg-Westend,*" is an example of a splendid plan for the care of babies during their first year. This institution starting in a small way has developed into a well rounded organization. It maintains a home for working women where they are kept during the latter part of pregnancy, in return for their board and lodging doing the light house work. At the time of their confinement they are transferred to one of the lying-in institutions from which they are, as a rule, discharged eight days post-partum. They are then received in the infant home where they remain three months, nursing their babies and doing light housework according to their physical ability. During this time an effort is made to prepare them to be self-supporting when they go out. Courses in sewing and dressmaking are given and it is also possible to receive special

training for work as a nursery maid and in housekeeping, cooking, washing, etc. This is absolutely without cost to the woman, it being only required that she shall nurse her baby and do her share of the light house work.

After three months, if she is in proper physical condition, she is helped to find work. She leaves her baby in the institution and during the day makes her living. At night she returns to the institution where she is with her baby. While she is earning her living she pays 20 marks a month for her child and 5 marks for her own care. The attempt is made to keep the mother and child together in this way for at least a year to a year and a half. The institution will keep both up to six years.

The *Säuglingsheim* has increased its usefulness by taking in, in a separate department, a certain number of children whose mothers are temporarily unable to care for them on account of sickness or from any other cause, and giving courses in the care of children to nursery maids and young mothers.

The German industrial insurance makes provisions for working women. There are, however, a large class who are not benefited by it. Following the example of France, *Mutterschaftsklasse* have been established in a few places—Karlsruhe in 1909, Heidelberg and Baden, 1910. Taking that of Heidelberg as an example, the membership is limited to the capacity of the office for handling records. Members must live and work in Heidelberg or within a radius of about eleven miles. Their income for the previous year at the time of enrollment must not have been over 3,000 marks. An increase of income after enrollment does not prevent continued membership. Everyone who has been a member for one year is entitled to premiums. Immediate notice of pregnancy and probable date of confinement must be given. Visitors or agents of the society must be allowed access to the house and must be given any information required concerning mother or child. Premiums vary from 20 marks to 40 marks according to the length of membership. These premiums are paid whether the baby is born alive or stillborn. Members nursing their babies for six weeks get a premium and further premiums are given for additional length of nursing.

In France and Germany are many volunteer organizations, which provide trained nursing care for women at time of confinement, and others providing helpers to do housework, etc. In Bavaria there are seventeen such organizations.

REGULATION AND TRAINING OF MIDWIVES

In the United States in many localities from 25 to 50 per cent. and more of the births are attended by midwives. Physicians are not allowed to practice obstetrics without a long course of training and passing the state examinations. And yet midwives are allowed to attend women prac-

tically unhindered. In thirteen states midwives are allowed to practice absolutely unrestrictedly and in fourteen others there is apparently no statutory requirement for training, licensure, or control. Even in the large cities there is no thoroughly satisfactory supervision, and training may be said to be totally lacking. Thirteen states provide for the examination and licensing of midwives and two others for licensing only. There is no supervision, and in New York city alone is an attempt made to supervise them. This sums up all that Carolyn Van Blarcom could find out for her report for the Committee on the Prevention of Blindness.

A beginning is, however, being made. In New York, in the face of considerable opposition, a "School for Midwives" has been started connected with Bellevue Hospital, where training is given, both theoretical and practical, under medical supervision. The candidates have both hospital and outdoor training.

The Department of health in New York City is formulating rules which are the most satisfactory in this country. No midwife shall hereafter be licensed unless she has graduated from a recognized school either in this country or abroad. The requirements for recognition of a school are quite rigid and are practically those of the Bellevue school.

The New York State Department of Health is also planning to issue regulations for the licensing and control of midwives. Pennsylvania has also recently passed a new law placing the licensing and control of midwives under the Bureau of Medical Education and Licensure.

Jacksonville, Florida, has passed an ordinance which states, "……it shall be unlawful for any person to engage in or perform the duties of midwifery as defined in this ordinance without having passed a satisfactory examination in the elementary principles of midwifery. It shall be the duty of the City Board of Health to provide, free of charge, instruction in the simple principles of midwifery which shall comprise such examination. The City Board of Health shall issue certificates to all persons, who shall obtain in such examination a grading of at least 75 per cent……." In a personal letter from the health officer, it is stated that the examination will cover the elementary principles of midwifery with especial reference to surgical cleanliness, prevention of tetanus, ophthalmia, etc. Many of the midwives are colored women, and they are given practical instruction by the colored nurse of the department.

In contrast to the general lack of attention to the midwife, Europe stands out strongly. In practically every country in Europe thorough training, examination and supervision of midwives is provided. In fact their training is better in many places than that given to many of our medical students.

DAY NURSERIES. CRÈCHES

In this country there are an enormous number of day nurseries. Many of them have existed for years and are not carried on on modern sanitary

lines. It is safe to say that the majority have no adequate medical supervision and are in some cases veritable hotbeds of infection. This is especially true of vaginitis. Properly carried on they may be made valuable means for the education of mothers.

In Chicago the Mary Crane Day Nursery is such an institution. It encourages mothers to nurse the babies during the midday hour, provides classes of instruction, recreation, etc., and is a sort of community center for poor mothers.

There is an Association of Day Nurseries which is attempting to make a careful study of all the problems arising, and to give advice and information as to the best methods of management. They can be made valuable forces in the campaign for infant welfare, but thorough medical supervision is essential, and they should all be under careful supervision of the health authorities as well.

In Europe their number is legion. In Germany they have been violently attacked owing to this lack of medical control, and medical supervision is becoming quite general. In many of them, too, a requirement is that mothers shall come at least once a day to nurse the babies.

In France day nurseries are probably more abundant than in any other country in the world. In Paris alone there are sixty-seven and in the suburbs thirty-nine. A ministerial decree lays down certain requirements as to space per child; forbids a room occupied by the children in the day time being slept in at night; requires that every child shall have its own crib, towel and comb; requires medical supervision, and sets as a standard one woman attendant for every six babies under 18 months of age, and one for every twelve over 18 months.

In an ever increasing number the crêches are demanding that the mothers shall come once or more in the day time to nurse their babies.

The industrial crêche is an interesting European feature. In Germany in at least nine places, large manufacturing plants have established modern, well-run nurseries for the breast-fed babies of women employees. In France there are a great number, and the government is setting an example by establishing "nursing crêches" in connection with two of its national factories.

In Austria, the government has established in its great tobacco factories, model nurseries under constant medical supervision and with skilled attendants. They are models of their kind in every way.

In Italy, Spain and Portugal also such nurseries exist.

"BETTER BABIES" CONTESTS

As a means of arousing popular interest in the subject of healthy babies, the "Better Babies" contest has met with immediate success. The method of carrying on these contests has varied extremely in different

places from a mere show with the awarding of prizes to babies adjudged most nearly perfect on a very unscientific basis, without any attempt at following up or doing any constructive work in the community where they are held, to a carefully arranged program carried out during several weeks and combining scientific medical examination with home follow-up work by nurses, and subsequent contests to show the improvement of babies. There is no question that the baby health contests in one or other of its forms is a most valuable weapon in the infant welfare movement. It is no less true that improperly managed and planned, it is absolutely useless and little short of a Roman holiday. The American Medical Association has undertaken to prepare a score card for these contests based on scientific principles, and the committee having charge of this scientific card are also preparing instructions as to the method of conducting them. Hundreds of these contests have already been held in the United States from one end of the country to the other. It is too soon to draw any definite conclusions as to their real value.

RURAL INFANT WELFARE WORK

The rural district is a problem by itself. So far almost all infant welfare activities have been confined to urban localities. The work of the Holman Association in the South and the Visiting Nurses' Association of Westchester County are instances of rural work. But they do not especially direct their work toward infants, and the problem is practically untouched in this country.

In Europe more has been done. In France the *Mutualités Maternelles* have extended into distinctly rural districts. The consultations for babies also have been carried on successfully for several years in rural communities.

Germany is becoming interested in this phase of infant welfare work. The Infant Welfare Society of the Administrative District of Dusseldorf, which comprises thirteen urban and fifteen rural communities, has organized traveling nurse work. This nurse visits in the rural districts, enlisting the interest of physicians and midwives, giving talks and demonstrations wherever she can get a few mothers and little mothers together, and doing also practical work when needed. "Mother and Child," the monthly publication of the society, is also sent to every midwife.

A similar organization exists in the Province of Hesse.

In Bavaria there are several traveling nurses and physicians who carry this work into the small villages. In the rural districts of Crefeld, Mörs and Solingen, similar work is being done.

In New Zealand the Society for the Health of Women and Children is doing much work of this kind.

ASSOCIATIONS FOR PROMOTING INFANT WELFARE WORK

In 1909 the American Association for the Study and Prevention of Infant Mortality was organized as a result of a Conference on Infant Mortality held in New Haven, Conn., by the American Academy of Medicine. This association aims to enlist the interest of all classes and callings in the problem of infant welfare in all its phases. Each year it has held a meeting at which papers dealing with various topics are presented and discussed. At its fourth annual meeting held in Washington in 1913, representatives were present from twenty-four states, the District of Columbia, Canada, Argentine, Italy and Scotland. Its membership is distributed in forty states, The Argentine, England, Scotland, New Zealand, Canada, China, Syria, Hawaii and the Philippines. Affiliated with it are ninety-one associations, health departments, women's clubs, etc.

The association maintains a travelling exhibit which is used in campaigns throughout the country, to arouse interest in infant welfare work. This exhibit has been from one end of the country to the other. The exhibit and the services of its executive secretary are always at the disposal of any locality desiring to start an infant welfare compaign.

The association publishes each year the transactions of its annual meeting together with reports of the recent work of its affiliated societies. The activities of the association are entirely research and extension work It cooperates most cordially with the Federal Children's Bureau and the Public Health Service.

It has recently prepared a simple, brief booklet on the "Care of the Baby," which was published by the Public Health Service in its weekly report. This is designed to meet the need of organizations doing infant welfare work and requiring literature for distribution.

There are many other organizations doing educational work of this kind, such as the Department of Child Helping of the Russell Sage Foundation and the New York Association for Improving the Condition of the Poor. Most of them, however, are engaged in field work rather than purely extension work.

In Europe there are numerous such associations. In Berlin is the Kaiserin Augusta Victoria House for Reducing Infant Mortality in the German Empire. It was founded to commemorate the recent jubilee of the German emperor. Its purpose is to carry on scientific and practical investigations into the feeding and care of infants and the protection and care of mothers; to accumulate information from Germany and foreign countries concerning infant mortality, and to publish information based on its scientific and practical investigations into all forms of infant welfare work. It possesses a well equipped department for its scientific research and another department dealing with practical

problems. Its central buildings contain maternity wards, "home for nursing mothers," infant consultations, milk laboratory, etc. It gives training for midwives, nursery maids and high-class trained nurses, one of its purposes being to create a demand for trained nurses in our sense of the word. It gives courses to young mothers in the care of children, and provides opportunities for physicians to do special work in pediatrics, social and medical. It also has its own milk herd and dairy.

Another active organization is the Society for Infant Welfare in Dusseldorf. It provides continuation courses for physicians in the physiology and hygiene of infancy, and infant welfare work; for veterinarians in hygienic milk production; for midwives in welfare work, and for nurses to prepare them for district and social service work among infants.

In Belgium there is an active National League for the Welfare of Infancy which is chiefly engaged in extension work.

When Pierre Budin died, the question of a memorial to the man who had done most for infant welfare in France was raised. Instead of a monument in his memory, it was decided to raise funds to start the Pierre Budin Foundation. An infant consultation is the center of this work and in connection with it are given courses in infant welfare for nurses, mothers, midwives, physicians, little mothers and others.

In England there is a National Association for the Study and Prevention of Infant Mortality and for the Welfare of Infancy. This association is bringing together the many activities being carried on in England and is furthering cooperation between the health authorities and private organizations and doing a great deal to eliminate the lack of harmony existing between the two. In August, 1913, an English-speaking Conference on Infant Mortality was held by this association in London. There were present official representatives of the United States and of many English colonies, including India, Australia, New Zealand and Canada. The work of this association is purely extension.

In New Zealand is the very active Society for the Health of Women and Children. The central association was founded in the city of Dunedin in 1907 and now has eight local branches scattered throughout the entire dominion. Its object is, in brief, to promote the health of mothers and babies through instruction and, to a certain extent, through skilled assistance in time of illness. The association has carried on a most vigorous campaign enlisting the interest of all classes of the population. It has formed seventy local committees, many of these in the sparsely populated parts of both islands. It has established seventeen visiting nurses in various parts of the dominion, who cover a definite territory, cooperating with the local committees in carrying on the work of instruction and supervision. Any mother in New Zealand may obtain the services of these so-called "Plunkett" nurses. In the rural districts

these nurses cover an area with a radius of fifty miles from their central station. They make periodic visits and in the interval the local committees see that instructions are carried out. Through cooperation with the newspapers of the dominion, each week in practically every newspaper there appears a column entitled "Our Baby." In this column are given the answers to questions received, as well as practical general suggestions on the care of babies. During the last year over 200,000 copies of this special newspaper article were distributed each week throughout New Zealand. Courses of lectures are given at frequent intervals in various parts of the islands on health matters relating to mother and child. The society maintains a small hospital for sick babies with a training school for nursery maids. Postgraduate courses are given to physicians at the hospital, as well as to the students in the domestic science course at the university. A book entitled "Feeding and Care of the Baby" has been printed, which deals exhaustively with preparation for maternity and the care of the baby. The work of the association is supported in part by voluntary subscription and by a generous grant from the dominion government. During the past year 711 families were dealt with by the Plunkett nurses, who made 5,394 visits.

EFFORTS AT COOPERATION

The enormous waste and duplication of effort in welfare work of all kinds, especially in that relating to infants, is gradually being appreciated. One of the earliest examples of cooperation in this country is that in Cleveland, which has been already described. In 1912 in New York, was formed the Babies Welfare Association, composed of representatives of sixty-five organizations doing work in any way related to infants. This association acts as a clearing house for information and is attempting to reduce infant mortality by reducing wasted effort. In the short period of its existence it has already made its need felt and the information which it distributes is being more and more utilized. It has headquarters in the New York City Department of Health and its work is carried on by various subcommittees, on social service, outings, milk stations, hospitals and dispensaries, better babies contests, publicity and statistics. At the central office is kept a file of all welfare organizations in the city, just what they are doing and under what conditions their assistance can be obtained. Anybody desiring information as to how to meet some particular emergency has only to telephone to the headquarters to obtain that information. If a visiting nurse finds a sick baby, it is no longer necessary for her to travel with the mother and baby from hospital to hospital during the hot season when hospitals for babies are crowded to their capacity, but a telephone message as to where there is room gives immediate information. If a social worker finds a mother who needs hospital care and does not know what to do

with the small children in the home, a telephone message gives her immediately the desired information. In addition to this work, the association has made studies along various lines of infant welfare work and issues each week a bulletin to its members and to all others interested, describing some particular activity being carried on in New York or elsewhere and also giving the infant mortality statistics of the city for the week in some detail. Through cooperation with the New York Milk Committee it is able to obtain information promptly as to the distribution of infant mortality in the city, thereby making it possible for public and private activities to turn their attention immediately to the areas of high morality.

In Philadelphia a similar organization has just been formed by the Child Federation. It is understood that it will be carried out along lines similar to the New York Association's work with more attention to research than is at present possible in New York. In many other cities similar attempts are being made with most satisfactory results.

INFANT WELFARE WORK AS A BUSINESS PROPOSITION

No stronger argument for the value of preventive work among mothers and babies is to be found than the entrance into the field of a great business corporation, the Metropolitan Life Insurance Company. This company realizes that the prevention of illness means money in its pocket. During the first half of the year 1912, nursing service was provided free to 6,374 maternity cases, to whom the nurses paid 50,794 visits. Its 11,000 agents distributed the company's booklet, "The Child," to all its policy holders. This little book is now in its third million. A pamphlet on milk and its care has been prepared and is now in press. The nursing service of the company in the first two months of 1914 covered 1,700 cities and towns.

The company also offers to cooperate with health officers in many ways. In Syracuse, for example, the agents send to the local health officer a post card bearing the name and address of every child under 1 year of age found in the families they are visiting. This is being done as an aid to the department in increasing the registration of births.

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